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CANADA CENTRE FOR INLAND WATERS

ANNUAL REPORT 1969

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Department of Energy, Mines and Resources
Fisheries Research Board
Department of National Health and Welfare

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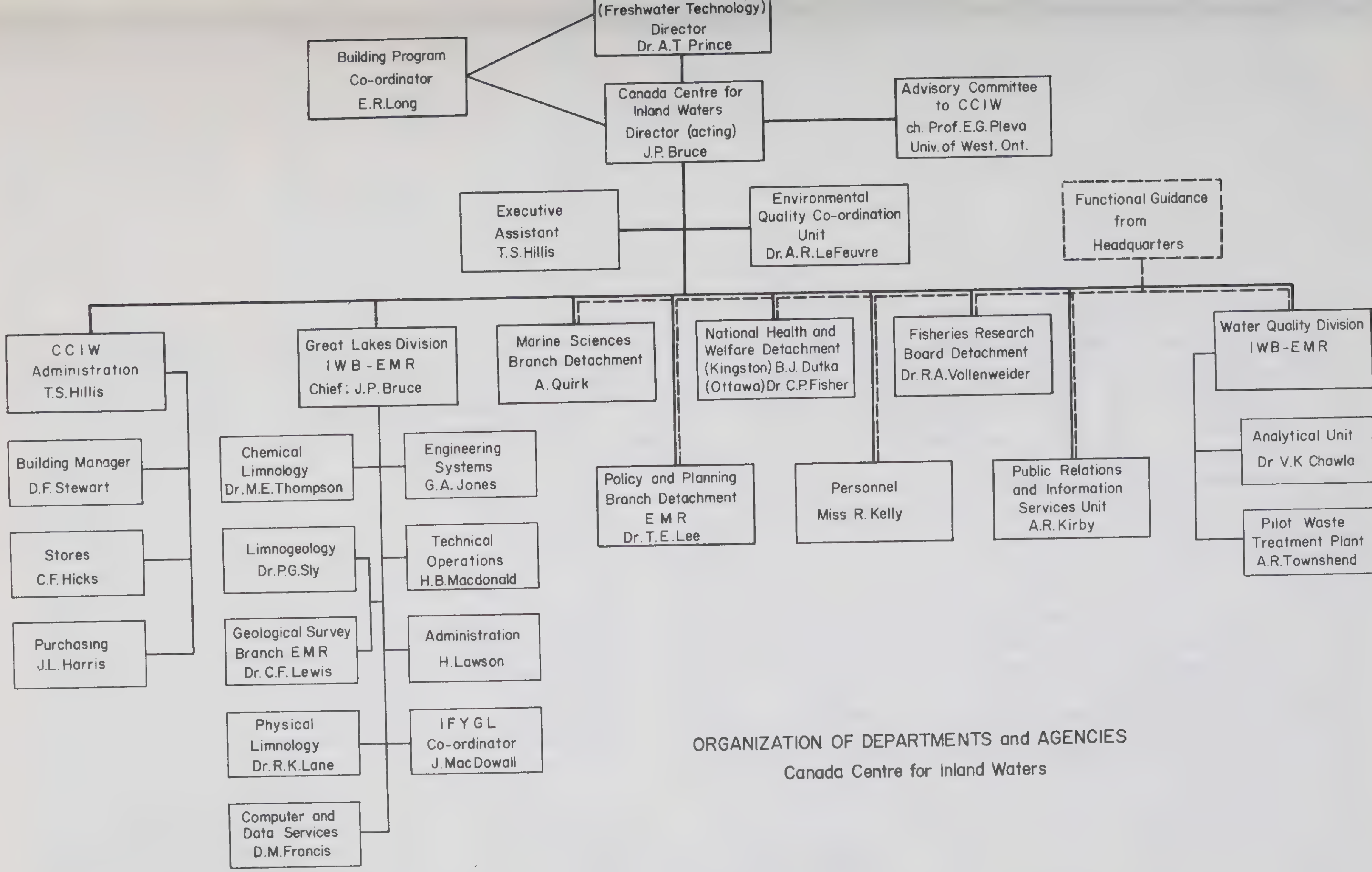
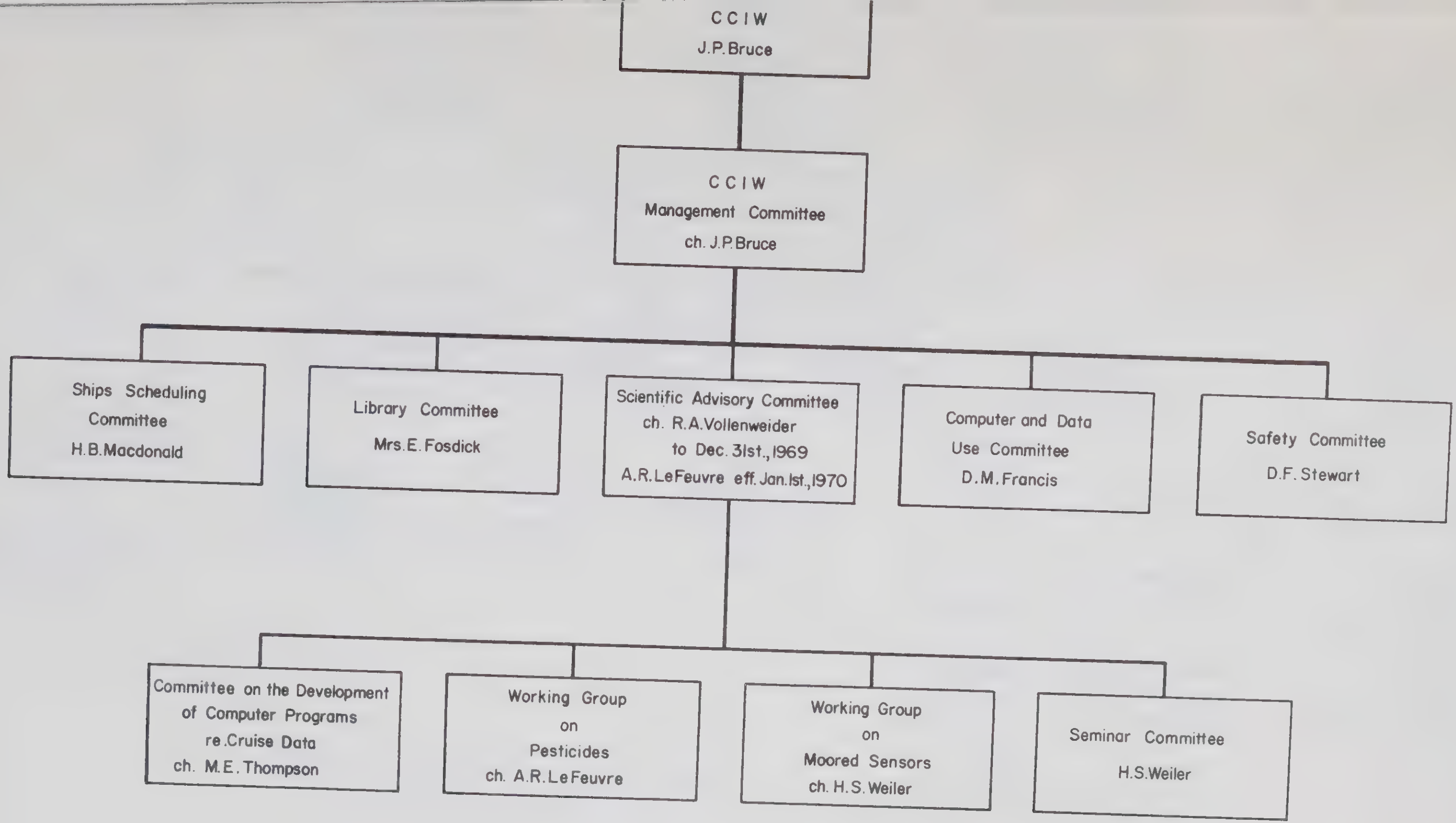


ORGANIZATION OF DEPARTMENTS and AGENCIES
Canada Centre for Inland Waters



INTERNAL COMMITTEE STRUCTURE
Canada Centre for Inland Waters

Dec. 31st., 1969

HIGHLIGHTS 1969

A number of important developments occurred at the Canada Centre for Inland Waters in 1969, the second full year of operation. The reports of the various Sections and Detachments on the following pages outline the more important of these and 10 deserve special mention.

1. Report to the IJC – Volume I (Summary) of *Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River* was published and released in October.

Much of the Canadian survey work for this report was carried out by the staff of the agencies associated with CCIW, who collaborated with their colleagues of the Ontario Water Resources Commission, other federal agencies and United States representatives.

The following staff members prepared sections of Volumes I, II and III: H.H. Dobson, P.F. Hamblin, Dr. R.K. Lane, Dr. C.F.M. Lewis, M.T. Shiomi, A.J. Stanley-Jones, Dr. H.S. Weiler, Dr. R.R. Weiler.

Dr. A.R. LeFeuvre edited Volume III on Lake Ontario with assistance from H.H. Dobson, Dr. V.K. Chawla and Dr. A. Lerman, under the general direction of the IJC Editorial Committee. Major contributions to the scientific basis of the recommendations concerning nutrient control were made by Dr. R.A. Vollenweider. J.P. Bruce served on the Editorial Committee.

The report contains 19 recommendations for control of pollution on the lakes based on present knowledge, but identifies a number of problems for which fully satisfactory scientific answers were not available. Research programs are under way or are being developed at CCIW to fill many of the identified gaps in our knowledge.

2. Federal Contingency Plan for Oil Spills – At year's end the federal government's contingency plan for dealing with major spills of oil and toxic material in all waters of federal jurisdiction was submitted to the Interdepartmental Committee on Water for approval. It makes provision for cooperative federal department response for containment and clean-up of spills in Arctic and coastal waters and will form the basis for negotiations with the provinces in connection with waters of joint jurisdiction, such as the Great Lakes. Initial plans for oil spill clean-up research were developed to help fulfill the Centre's obligations under the federal contingency plan. J.P. Bruce served as chairman of the Interdepartmental Working Group which developed the plan. Dr. LeFeuvre was appointed interim convener of the Technical Working Group, one of the two working groups established for implementation of the Plan. F.M. Boyce of the CCIW prepared the technical section on oil spill containment and clean-up methods for the report to the IJC, *Potential Oil Pollution Incidents from Oil and Gas Well Activities in Lake Erie, their Prevention and Control.*

3. Socio-economic Unit – A socio-economic research unit was established in November by Policy and Planning Branch of Energy, Mines and Resources. Research programs in economics, sociology and geography complementary to existing natural sciences programs are being developed under the direction of Dr. Terry Lee by the four staff members of the Unit.

4. Public Information – A Public Relations and Information Services Unit was established by A.R. Kirby. In addition to organizing the Centre's response to requests for speakers, radio, TV and press interviews, articles, and visits to the Centre, the Unit developed an initial plan for a longer-range information program.

5. Environment Quality Coordination Unit – The Environmental Quality Coordination Unit was established in June with the appointment of the unit head Dr. A.R. LeFeuvre. This Unit is responsible for coordinating the results of research from the various disciplinary groups of the Centre and for converting these results into reports directed to pollution abatement programs and policies. The Unit has concentrated on completion of the Centre's share of the IJC pollution reference report on the organization of the federal contingency plan and on development of an interdepartmental program of pesticide research.

6. Construction – Construction of the first of the permanent buildings of the Centre began in October. Occupancy of the first-phase buildings, the workshop-warehouse, research and development building and central heating plant is scheduled for summer, 1970. A decision was made to advance the construction schedule for the water quality pilot plant for testing promising new industrial and municipal waste treatment methods. It will now be built during 1970. Mr. A. Townshend joined the staff of the Water Quality Division to coordinate scientific plans for this development.

7. Scientific Papers – Scientific staff members produced many significant papers during the year. At the annual Great Lakes Conference of the International Association for Great Lakes Research in Ann Arbor, Mich., the 17 papers presented by CCIW staff were the largest number from any one research centre in North America. A total of 47 papers were published by staff members during the year (Appendix C).

8. Advisory Committee to CCIW – The Advisory Committee to the Canada Centre (ACCC) chaired by Prof. E.G. Pleva of University of Western Ontario, contains seven university members, six members from the private sector, and six representatives of the federal and provincial governments. At the request of its parent committee, the National Advisory Committee on Water Resources Research, the ACCC developed initial guidelines for a new program of non-university research contracts and grants and made recommendations concerning the first contracts. Once familiar with the Centre's program, this committee will advise CCIW management on research priorities and programs, including the most effective allocation of space and facilities at the Centre for the university community (Appendix D).

9. Contracted Research Programs – In addition to its intramural programs, the Centre contracted 11 research programs to universities or private consultants. These ranged in price from $13,000 to $36,000 and in scope from studies of reasons for die-off of alewives to a survey of waste heat inputs to the Great Lakes projected to the year 2000.

10. Canadian Coordinator – As a con[...]bution to the International Field Year for t[...] Great Lakes, the office of Canadian Coor[...]nator was established in the Great Lakes Di[...]sion at the Centre. Mr. J. MacDowall took [...] his duties in this capacity in February.

Some of the activities planned for CC[...] during 1970 are:

The central region of the Canadian Hyd[...]graphic Service, Marine Sciences Branch, w[...] move to the Centre from Ottawa to carry o[...] its function of charting waterways from Fath[...] Point to the Alberta border.

Interdisciplinary, inter-agency task forc[...] will be established to carry out well coor[...]nated studies of lake eutrophication (chairm[...] – planning committee, Dr. R.A. Vollenweide[...] and of oil spill detection, containment a[...] clean-up (chairman – planning committee, D[...] LeFeuvre).

The first of the permanent buildings will [...] occupied.

The main laboratory building and the pil[...] sewage treatment plant will be started. T[...] former is scheduled for completion in 1972 a[...] the latter in early 1971.

Although some work has been done b[...] Centre staff on Lake Winnipeg, the Keno[...] region lakes and Lake Diefenbaker, the fir[...] major project involving Great Lakes Divisio[...] outside of the Laurentian Great Lakes Basin wi[...] be started on Lake Okanagan under a join[...] Canada-British Columbia agreement.

After the passage of the Canada Water Ac[...] more participation of the Centre's staff [...] expected in federal-provincial projects acros[...] Canada.

ENVIRONMENTAL QUALITY COORDINATION UNIT (EQCU)

The EQCU coordinates the results of re[...]search produced by the various disciplinar[...] groups of the CCIW and prepares report[...] recommending policies on water quality an[...] methods of controlling pollution. The Coordi[...]nator advises the Director of the Centre o[...] pollution research and on development o[...] programs in this field. He assists in providin[...] liaison with provincial and federal pollutio[...]

atement agencies and with their counterparts the United States.

The efforts of the EQCU since its formation June have been directed to three major pics: the development of a national contin-ncy plan for combatting spills of oil or other zardous materials, establishment of a cooper-ive pesticide research program in the Great ikes, and the editing of Volume III (Lake ntario) of *Report to the International Joint ommission on the Pollution of Lake Erie, ake Ontario and the International Section of e St. Lawrence River.*

The ever-increasing threat of a major spill of l or other hazardous materials into Canadian aters has prompted the federal government to evelop a contingency plan for such an even-iality. This plan is now undergoing formal pproval. It was developed in many stages. The any departmental interests were included rough the coordinating machinery of the nterim Interdepartmental Committee on Vater. The EQCU was responsible for coordi-ating the preparation of the several drafts of his plan.

Public awareness of the dangers of certain esticides to the environment and possibly to nan himself, particularly the chlorinated ydrocarbons, led to considerable government ction. In response to this awareness and also to ffect some coordination in the Great Lakes egion between various federal departments lready active in this research area, a coopera-ive research program on pesticides in the Great Lakes is being developed. This will involve several federal agencies (National Research Council, Dept. of Agriculture, Canadian Wild-life Service), in addition to those participating in the Centre's regular program. The EQCU has been chairing the working group of the Scien-tific Advisory Committee charged with develop-ment of this program. The program will get under way in 1970.

The reference to the International Joint Commission on pollution of Lake Ontario, Lake Erie and the international section of the St. Lawrence River resulted in the preparation of a comprehensive report. This three-year effort by the federal governments of the United States and Canada and the states and provinces bordering the lakes, is presented in three volumes. Volume I, which is the summary and recommendations of the report, was released to the public in the fall of 1969.

Volumes II and III are the detailed tech-nical reports upon which the summary and conclusions were based. Volume II is on Lake Erie and Volume III is on Lake Ontario and the international section of the St. Lawrence River. The EQCU edited Volume III of this report, under general guidance of the Pollution Refer-ence Board Editorial Committee, in preparation for its printing and release early in 1970. This task, now substantially complete, was a major undertaking of the Coordinator and his staff.

FISHERIES RESEARCH BOARD DETACHMENT (FRB)

During 1969 the Fisheries Research Board participated in 13 cruises of the *MV Martin Karlsen*, six of the *CSS Limnos*, five of the *CCGS Porte Dauphine*, and one hovercraft operation. (Ontario – 15, Erie – 5, Georgian Bay – 2, Huron – 1, Superior – 2); 709 zooplankton and 748 phytoplankton samples were collected. (Ontario – 433 and 437, Erie – 141 and 176, Georgian Bay – 29 and 29, Huron – 51 and 51, Superior – 55 and 55).

On all cruises, chlorophyll distribution was recorded by continuous fluorometer techniques (Turner Model No. 111), as in previous years. A large fraction of the data collected has already been prepared in the form of charts showing spatial distributions. The preliminary results confirm the existence of the strong horizontal and seasonal variations observed in previous years. In addition, it is noted that, generally, the chlorophyll concentrations in Lake Ontario and Lake Erie decrease from west to east, although this is not always the case. The average chlorophyll values of Lake Erie are 2 to 3 times higher than those found in Lake Ontario.

Preliminary studies in a lake-wide moni-toring program, to continue in 1970 on primary and secondary production in the lower Great Lakes, has been initiated by new staff members. These studies include also an analysis of limit-ing nutritional conditions of photo-synthesis in these lakes (bioassays using ^{14}C), and studies of the natural phytoplankton communities. Con-

current studies of nutrient concentrations (nitrogen, phosphorus, trace elements) have been initiated by Water Quality Division and the Chemical Limnology Section.

Although this work is in its first phase only, a number of interesting results have already been obtained. Dr. J. Vallentyne's finding that phosphorus is a strong controlling factor in plankton production in Lake Ontario and Lake Erie appears to be confirmed, but the studies have shown that, at times, micro-elements, in particular manganese, play a limiting role.

Microscopic analyses of phytoplankton from Lake Ontario have shown that in earlier studies nanoplankton, particularly flagellates, have been neglected. Among the new records, *Cryptomonas erosa, Rhodomonas minuta, Carteria cordiformis, Carteria klebsii, Chlamydomonas mucicola, Katablepharis ovalis,* and further, *Scenedesmus bijuga, Oscillatoria limnetica* have been found in larger amounts in the western part of the lake.

Much time has been devoted to improving sampling and analysis techniques. A new device to separate zooplankton from filamentous algae has been developed by a member of the FRB staff, in which advantage is taken of the behaviour pattern (geo- and phototaxis) of zooplankton. The sensitivity of a Furuno Echosounder to locate zooplankton and turbidity layers in situ has been tested, and studies on the use of Coulter Counter techniques have been continued. In cooperation with the Engineering Section, an integrating water sampler and a thermo-photostat for primary production measurements onboard ship have been developed.

The FRB Eutrophication Section, Freshwater Institute, Winnipeg, has contributed to Great Lakes studies in a number of ways.

Dr. J. Vallentyne completed a study on the effects of treated and untreated sewage on algal growth using natural water from Lakes Ontario and Erie. Untreated, or treated sewage, which contain high proportions of phosphorus (phosphorus not eliminated, or with phosphorus-reconstituted treated sewage), definitely stimulates algal growth in both lakes in comparison to sewage of low phosphorus concentration (phosphorus eliminated by lime precipitation).

Dr. K. Patalas has studied the mater collected during 1968 in Lakes Ontario, Er Huron and Superior, investigating species co position, horizontal distribution and amour of the crustacean plankton in all lakes. No worthy correlations between heat conter nutrient load and seasonal cycles of sing species, as well as total amount of crustace plankton under a unit of surface, have be found.

Dr. J. Stockner is analyzing the diato residuals in two cores from Lake Erie (one fro the eastern, the other from the western end) order to assess changes in the state of eutr phication of this lake during past history.

Mr. W. Warwick, Limnogeology Sectio who is on education leave at the University Winnipeg continues his studies in collaboratic with Dr. A. Hamilton, FRB, on bottom faur of the Great Lakes.

GREAT LAKES DIVISION

Chemical Limnology Section

During the past year, a considerable part the Section's effort was diverted from purel laboratory studies to field studies, notably cooperation with Physical Limnology's Proje MELON, in western Lake Ontario. Members the Section also participated in the Lake Er Time Series study organized by Dr. J.R. Krame of McMaster University, and the success of th effort has led to the planning of two simil fixed-station studies for 1970.

During 1969 an in-house course in lo temperature aqueous geochemistry was begu for and by the staff of the Section; it was als attended by several members of the Limnog ology Section and one from Engineerin Systems.

Two postdoctoral research fellows came t the Section during 1969. Dr. M. Munawa whose interests are biological and chemical, wa assigned to the Fisheries Research Board de tachment to do research initially under Dr Vollenweider's guidance. Dr. C.W. Childs, wh is interested in the physical chemistry o aqueous solutions, will work closely with Dr R.F. Platford.

Chemical Monitor Cruises – The Chemica Limnology Section is responsible for the plan

ng and evaluation of the results of the emical monitor cruises on the Great Lakes. ne samples are collected by personnel of the perations Section, Great Lakes Division, and nalyzed by Water Quality Division. Several oncurrent research projects of other sections agencies at the CCIW make use of the cruises the data from the cruises. During 1969 a ontract was arranged with Prof. J.R. Kramer f McMaster University to develop computer rograms to facilitate retrieval and analysis of ne chemical and related biological and bacte-ological data.

Lake Ontario was subjected to intensive nonitoring during 1969, cruises being sched-led every four weeks during the year (April 969 to March 1970), while only one or two ruises were carried out on the other lakes.

Papers were published on trace element istribution in Lake Erie and on water quality n the Great Lakes in collaboration with Water Quality Division staff, based on 1968 field data. nalyses of the 1969 cruise results are under vay and will form the basis of cooperative apers with Water Quality Division and Fish-ries Research Board on trace elements and hlorophyll *a*, and on nutrients in Lake Ontario.

Lake Erie Time Series – During July 1969, personnel of the Section participated in a time eries study in the western basin of Lake Erie. A number of chemical, biological, meteorolo-gical and physical parameters were monitored nearly continuously for several weeks, during both calm and stormy weather. The CCIW provided the barge, built a small laboratory hut that was installed on the barge, and provided much of the analytical equipment. Reports on the projects are being prepared for the 1970 Conference on Great Lakes Research in Buffalo. As noted, this project was coordinated by Prof. Kramer of McMaster University. Other participating agencies were the U.S. Bureau of Commercial Fisheries and the Federal Water Pollution Control Administration.

Precipitation Chemistry – During 1969, rain samplers were installed at several stations on the Canadian shore of Lake Ontario: Trenton, Kingston, Toronto Island, Toronto-Woodbridge, Ancaster, and at CCIW, Burlington. The samplers were constructed according to the design of Gambell and Fisher, 1966. (A.W. Gambell and D.W. Fisher, 1966, *Chemical Composition of Rainfall, Eastern North Carolina and Southeastern Virginia:* U.S. Geological Survey Water-Supply Paper 1535 K, 41 p.)

The purpose of the project is to assess the contributions to the chemical budgets of the lakes from atmospheric sources. During 1970, dust collectors will be mounted on *CSS Limnos* and the *MV Martin Karlsen.*

Soluble Organic Compounds in Large Lakes– During 1969 a Micro Tek 220 research gas chromatograph, with dual flame ionization detectors was acquired. This instrument is being used to effect separation of the dissolved organic material, extracted from lake water, into individual compounds. The instrument capability will be enhanced by the addition of flame photometric and thermal conductivity detectors in 1970. These detectors will allow the specific detection of phosphorus- and sulphur-containing organics and the collection of individual components for further analysis.

A Perkin Elmer 457 infrared spectrophotometer was also acquired in 1969 and is used in conjunction with the gas chromatograph for the identification of separated organic compounds.

Surface Area Measurements of Sediments – Adsorption of organic matter of the ions of various elements plays an important role in the lacustrine environment. For example, the concentration of various trace elements can be controlled by adsorption (Krauskopf, Geochim. Cosmochim. Acta **9**, 1 [1956]). Also, these adsorbed ions may be transported by sediment movements and released in a different environment (Carritt and Goodal, Deep Sea Res. **1**, 224 [1954]). Organic matter adsorbed by sediments, especially argillaceous deposits, may become unavailable for metabolic purposes (Oppenheimer, Geochim. Cosmochim. Acta **19**, 244 [1960]).

The amount adsorbed is determined by the surface area available, which depends on the way the total area is distributed between the geometric or external areas of particles and the internal area represented by various sized pores, since some molecules may be too large to enter

smaller pores. Hence, both the total and the external areas are important parameters to be measured.

A steady-state flow permeameter was constructed based on the designs of Orr (Anal. Chem. **39**, 834 [1967]) and a transient flow unit based on the designs of Kraus and Ross (J. Phys. Chem. **57**, 334 [1953]). From steady-state flow, two different types of areas can be calculated. The Poiseuille area represents the geometric or external area of a porous particle and does not include the internal area represented by the pores in the particle. The Knudsen area represents the internal area of a porous particle, excluding the area represented by "blind" pores. The area calculated from transient flow should be equivalent to the BET area measured by gas adsorption.

The equipment was tested using deep sea sediments examined previously (Weiler and Mills, Deep Sea Res., **12**, 511 [1956]). The Knudsen areas ranged from 1 to 34 per cent of the BET areas indicating that some types of sediment have very many "blind" pores. The Poiseuille areas ranged from about 5 to 50 per cent of the Knudsen areas. They agreed reasonably (within a factor of 2) with the geometric areas calculated from particle size distributions. The areas obtained when nitrogen was used as the permeating gas agreed with those obtained when helium was used.

Transient flow measurements were done on a few selected samples, using both helium and nitrogen. The helium areas were slightly higher than the BET nitrogen areas, whereas the nitrogen areas were considerably lower. These results agree with those of Kraus and Ross. This method, although the equipment for it is quite simple, was judged to be too slow and cumbersome for routine measurement of surface area and a Perkin Elmer Sorptometer (Model 212-D) was purchased for this purpose.

Computer programs have been written for calculating Knudsen and Poiseuille areas from experimental data and for calculating pore size distributions from desorption isotherms.

Interstitial Water – During the summer of 1969 sediment cores were taken at four stations in western Lake Ontario, using a Benthos Model 2170 gravity corer. Each station was sampled six times at two- to four-week intervals. The core liners were capped and stored in ice ch for later processing on shore. The interst water was expressed from the sediment usin all plastic gas-pressured squeezer modified f the design of Reeburgh (W.S. Reeburgh, 19 An improved interstitial water sampler, Lim and Oceanog. **12**, 163). Both the interst water (during squeezing) and the water trap in the corer immediately above the sedim were passed through 0.45 μ filters and w analyzed for major ions, iron, mangan phosphate, nitrate, and silica. Eh and pH w measured by applying the electrodes direc to the mud. The most satisfactory Eh measu ments were obtained by inserting a pa shielded gold wire into the centre of mud core.

Samples from the top two inches of sediments were sent to B.J. Dutka of Dept National Health and Welfare, Kingston bacteriological studies.

There was little variation in the chemi properties of the sediments over the course the summer. The pH of the interstitial wa varies between 7.5 and 8.2, and the Eh in th of the cores ranges from −200 to −400 mi volts, but in the sandy core taken off Toron the Eh is about +250 millivolts. In the low samples the sulphate content of the intersti water is near zero, presumably because it h been reduced to sulphide species; bicarbonate increased by an amount equivalent to the l sulphate.

A more complete discussion of the chem try of the interstitial water will be presented the 1970 Conference on Great Lakes Resear in Buffalo.

Radioisotopes in Lake Sediments – T study is a preliminary assessment of the dist bution of fallout radionuclides in the sedime for the purpose of determining rates of se mentation diffusion through the sediment po space.

Sediment cores were taken in deep parts Lake Ontario and Lake Superior. Benth corers were used, with butyrate core liners $2^5/_8$ in. ID. In order to facilitate the separati of narrow layers of sediment, the core line were pre-cut into centimetre-long sections, a sealed together again with teflon tape. T reconstituted core liners then contained abo

170 subsections, but were strong enough to take satisfactory mud cores. The samples are being counted at the Radiation Protection Division, Dept. of National Health and Welfare, Ottawa, in Dr. H. Tanaguchi's laboratory.

Geochemistry of Brines — The primary problems of this study are modes of formation of various brines by such processes as evaporation and chemical reactions between sediments and ground waters. An early stage in the formation of the brines in which the predominant anion is chloride, are reactions between ground waters and limestone rocks, in the course of which the brine becomes relatively enriched in calcium and depleted in magnesium. When this process results in the calcium concentration becoming higher than the concentration of sulphate and carbonates in the brine, loss of water from the brine leads to precipitation of calcium carbonate and sulphate minerals. The residual brine becomes progressively richer in chloride until eventually sodium chloride (mineral halite) may begin to precipitate.

A computational model for this process is in good agreement (Lerman, 1969) with experimental data on the saturation of brines with respect to halite.

Methods are at present being developed for assessing the development of sulphate-rich lake brines and prediction of the precipitation of sodium sulphate minerals.

Trace Element Studies — A Jarrell-Ash atomic absorption spectrophotometer unit (Model 820-528) arrived in February. The instrument is equipped with two gratings covering the wavelength 1,850-9,000A° and an eight-speed electrical wavelength scanning device.

Microanalytical methods for determination of molybdenum and vanadium in lake water have been developed (Chau and Lum-Shue-Chan, 1969, 1970) and studies of these elements in the lakes are in progress. Recently, a sensitive method for mercury detection was developed, based on atomic absorption of the mercury vapor. Mercury in water is concentrated by dithizone extraction. Sensitivity for water is 0.008 μg/1 (.008 ppb). This method will be used to study the distribution and occurrence of mercury in the lake water and aquatic organisms.

Other equipment used for the trace element studies include a Nuclear-Chicago gamma counting system (Model 4454), with a thallium activated NaI well, and a Geiger counter for counting both gamma and beta radiation. The system is used in radiochemical experiments to assess the recovery of a trace element from water and yield in a chemical process.

Phosphorus Cycle in Lake Ontario — Only very limited work has been done on the fractionation of the forms of phosphorus in Lake Ontario waters. This study was designed to determine the relative size and importance of, and seasonal changes in, the soluble organic phosphorus fraction in western Lake Ontario waters. The project was coordinated with the Physical Limnology Section's project MELON. Lake water samples were collected at ten stations in the western basin of Lake Ontario at approximately two-week intervals from May to September. The water samples were filtered through 0.45 micron membrane filters onboard ship, then immediately frozen in dry ice for subsequent analysis at the CCIW.

A secondary aim of this project was to compare two methods of analyzing for soluble organic phosphorus in natural waters: the determination by the difference between total soluble phosphorus and soluble reactive phosphate and the U.V. irradiation technique (Armstrong, *et al.*, 1966, Nature **211**, 481-483).

The soluble organic phosphorus makes up a significant part of the total soluble phosphorus fraction in the surface waters of western Lake Ontario — at times when the soluble reactive phosphate concentrations are extremely low there can be up to 30 ppb (as PO_4) soluble organic phosphorus. This is a potential source of phosphorus for algae nutrition via bacterial conversion of the organo-phosphorus compounds to inorganic phosphate.

Use of the U.V. irradiation technique was started late in the field season; however, the preliminary indications are that it determines the same quantity in Lake Ontario waters as does the difference method. A more detailed evaluation will be undertaken in 1970.

Physical Chemistry of Aqueous Solutions – This program is concerned with the measurement of thermodynamic properties of aqueous mixed salt solutions in the temperature range from the freezing point to 25°C. Both an isopiestic vapor pressure apparatus and a freezing point apparatus are available, each of which can be used to determine the water activity of aqueous solutions containing involatile solutes. The isopiestic apparatus is particularly well suited for low-temperature measurements, and is now being used to study salt solutions at 15°C and 0°C. The freezing point apparatus can be used to temperatures for 0°C down to −4°C.

The activity coefficients of both salts in a two-salt system can usually be calculated from either of these measurements. The primary quantity measured, the water activity can be determined for most aqueous solutions with an inaccuracy of less than one part in 10^4.

The following systems have been or are being studied.

at 25°C

$H_2O - Na_2B_4O_7$
$H_2O - K_2B_4O_7$
$H_2O - NaBF_4$
$H_2O - KBO_2$
$H_2O - H_3BO_3$
H_2O – paraquat dichloride
$H_2O - CaCl_2 - Ca(NO_3)_2$
$H_2O - CaCl_2 - Mg(NO_3)_2$
$H_2O - MgCl_2 - Ca(NO_3)_2$
$H_2O - MgCl_2 - Mg(NO_3)_2$
$H_2O - Ca(NO_3)_2 - Mg(NO_3)_2$

at 15°C

$H_2O - NaCl$
$H_2O - Kcl$
H_2O – Urea
$H_2O - NaCl - MgSO_4$
$H_2O - NaCl - Na_2SO_4$

at 0°C

$H_2O - NaCl$

Particulate Organic Matter – A program carried out on Lake Ontario during the summer of 1969 has led to the development of a technique for measuring the rate of fall (cm/day) and settlement rate (gm/m^2 day) of organic particles in the water column. An example of obtainable values is shown in Figu 1. This technique makes possible the calcu tion of the rate of decay of organic matter different depths and an estimation of t quantity of organic matter settling onto t bottom of a lake. This information will then used in a study of the carbon cycle in lakes.

Computer and Data Services

Computer Terminal – A Control Da Corporation 200 user terminal was installed CCIW in March. The 200 is capable of handli 300 cards per minute and 300 lines per minut During 1969 more than 7,000 computer ru were made via the terminal which is tied McMaster University's Control Data 6400.

Shipboard Computer – Field trials we held during April and the PDP-8 comput performed satisfactorily. The computer w placed aboard *CSS Limnos* in September an used until December to reduce and reco various laboratory-determined parameters an temperatures. Next year the computer will b installed in a van for easier and safer transport tion.

Programs – A program to reduce and ana lyze the reversing thermometer data was d veloped and has been in production. Othe programs written during the year were for:

- current meter data, quality control an analysis
- curve fitting and trend surface analysi
- Hymet. recorder data analysis
- STAR data quality control, editin retrieval and analysis (in conjunctio with McMaster University) – for limn ological data collected from monito cruises.
- lake circulation modelling programs
- a generalized time-series data storage an retrieval system (under development).

During 1969, data from 35 Lake Ontari cruises, 11 Lake Erie cruises, three Lake Huro cruises and one Lake Superior cruise wer processed for computer listing and analysi Additional data from shore-based analysis an from other agencies were added to 1968 dat summaries and punched-card files. Data record of the 1966 monitor cruises were publishe

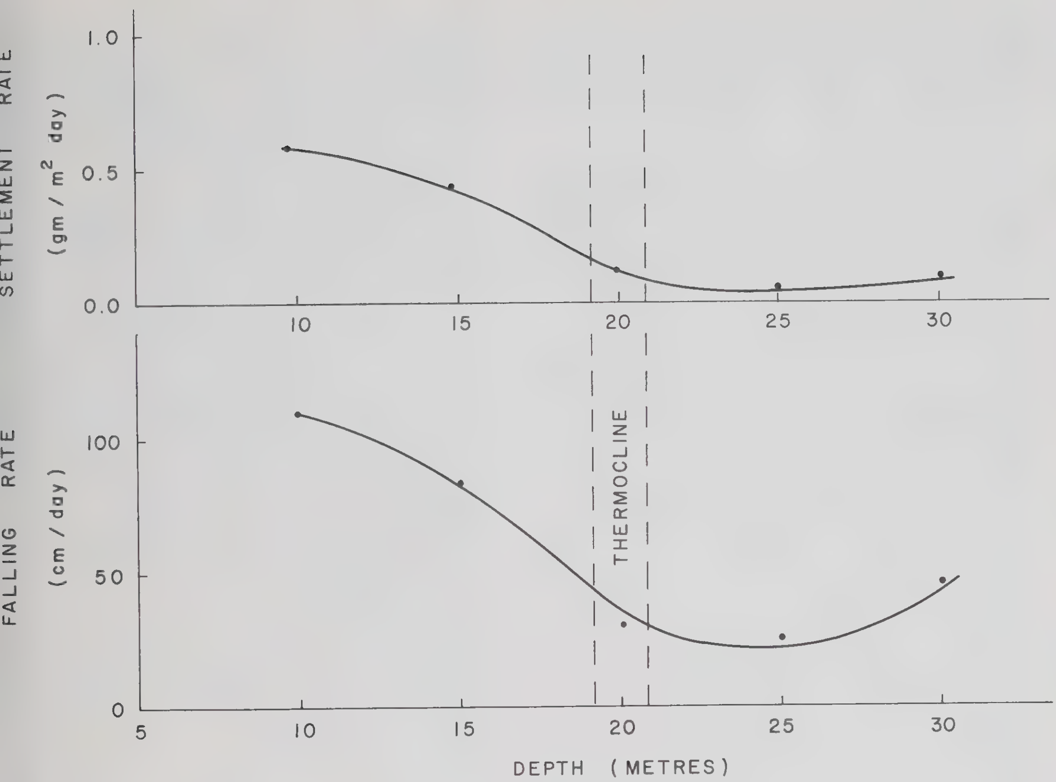


Figure 1. Settlement rates and falling rates or organic matter in western Lake Ontario – July 15, 1969.

(Appendix C). Data from 1967 monitor cruises will be published in 1970.

Although the Canadian Oceanographic Data Centre in Ottawa continued to process bathythermograph data, the thermocheck program and keypunching and listing of data in preparation for provisional reports are now being carried out at CCIW. This permits an earlier comparison of the temperature, physical and chemical parameters measured with those of preceding cruises or in past years. Immediate reviews of reversing thermometer and bathythermograph performances were implemented to permit recalibration of instruments for shipboard use whenever necessary.

Engineering Systems Section

Generally, the Section provides engineering services to all divisions and agencies of the three federal departments of the CCIW and to the scientists of the Association of Universities and Colleges of Canada participating in the research programs of the Centre. Engineering services are provided for research and data collection programs in the disciplines of bacteriology, biology, chemical limnology, hydraulics, limnogeology and physical limnology. These services include the design, development, implementation and maintenance of limnological instrumentation systems and automatic data acquisition and processing systems. A description of some of the more novel projects and activities follows.

Data Translator – To translate data from 1/4-in. magnetic tapes, produced by Plessey and Geodyne current meters, and punched paper tapes, produced by the automatic data acquisition systems onboard the major ships, a "translator", comprising a PDP-8 computer and the necessary hardware and software, has been assembled. The data are translated to computer-compatible format on 1/2-in. magnetic tape for data reduction and processing in a large computer. The programming of the translator's computer is such that a "diagnostic" of the

input data tapes is printed out, which gives an indication of errors in the data and thus assists in the editing of data and the assessment of meter performance.

Current Meters — Plessey current meters were serviced on 113 occasions for lake moorings, during the field season. Test and documentation procedures were developed and established to ascertain and improve the reliability of the current meters.

Twenty-two Geodyne current meters were received and passed through incoming inspection. Eighteen Geodyne current meters were serviced for mooring in the lakes, with good results. Documentation and test procedures were also established for these current meters.

Maintenance and service manuals were written for both types of current meters and steps were taken to initiate external maintenance and servicing by contract.

^{14}C Apparatus — This is an incubator for nutrient bio-assay involving measurement of photosynthesis rates of phytoplankton. The rates are determined by the amount of Carbon 14 absorbed. The incubator consists of a counter-balanced light bank and exhaust hood (for cooling) which gives a high intensity light source approaching daylight over a 6-square-foot open tank. The tank is fed to a constant height with raw lake water in which are submersed two rotating bottle racks with capacity for 40 sample bottles. The apparatus was made for the Fisheries Research Board and is now installed on the *MV Martin Karlsen.*

Microbiological Sampler — A prototype microbiological sampler was designed and manufactured for the Department of National Health and Welfare to obtain uncontaminated water samples at various lake depths and to use these samples for bacteriological studies. The instrument consists of a sealed, evacuated and sterilized flask mounted in a frame. The inlet to the flask has a length of folded rubber hose connected to it, which is sealed by a glass plug. In operation, the microbiological tester is mounted on a taut wire and lowered to a known depth at which time a dead-weight messenger is dropped to break the glass seal of the evacuated flask and also to release one end of the rubber hose so that water is drawn in the flask from a point remote from the a paratus thus avoiding contamination of t sample. Field testing has been successful and s more units are under construction.

Meteorological Packages — A "met. pacl was designed for remote meteorological obse vations from buoys, lake towers and sho stations. Ten units were built and tested durir the field season with reasonably good result The met. packs consist of a water-tight cylind containing a magnetic tape digital recorder ar battery pack. Arms are provided which carr wind speed, wind direction, humidity, an temperature sensors. The met. pack is suitab for taking a set of meteorological data a 10-minute intervals for 40 days of unattende operation in a remote location.

Tests undertaken by the Physical Limno logy Section indicate that while the syster meets the minimum design requirements, deve opment work continues toward improving it reliability and accuracy.

ADAPS — The "automatic data acquisitio and processing systems" automatically an continuously measure and process meteoro logical, limnological and navigational dat gathered during CCIW's ship operations. Thi project also includes various dedicated data logging systems. Specifications have been writ ten and approved for both the sensors and th data-logging portions of the system to thes specifications for the 1970 field season. Im portant features of the system are ease of dat quality checking, data processing and capability of manual data entry.

Installation, Repair and Maintenance - About 60 per cent of the Engineering System Section's man-hours are used on installation, re pair and maintenance functions. On the me chanical side, the major effort was on ship an launch equipment, particularly winches. On th electronics side, the major effort was in curren meter maintenance and data acquisition sys tems on ships, launches, towers and buoys. It i anticipated that contracting of current-mete maintenance in 1970 will permit much more time for development of water quality senso packages and other related instrumentatior systems.

Physical Limnology Section

Introduction — The Physical Limnology Section plays a role within the framework of CCIW by conducting research on the hydrodynamic and thermodynamic behaviour of lakes, by undertaking studies of applied limnology in circumstances where short-term studies are required, and by providing climatological and descriptive services in various aspects of physical limnology.

Niagara River Plume Studies — Data collected during 1967 and 1968 by current meters, drogues, infrared scanning, temperature surveys, and dye plume studies were employed to study circulation, thermal and diffusional characteristics of the Niagara River effluent. The orientation of the heavily polluted plume was found to be most responsive to wind direction, yet fairly insensitive to wind speed. Winds during and one day prior to the day of measurement were most closely related to the response of the plume although some effect of winds for three prior days was noted. The plume close to the river mouth was vigorously mixed. Outside the mouth area the warmer plume was found to spread horizontally over cooler lake water.

Air-lake Interaction — Wind, temperature, and humidity profile data collected during 1967 at the tower near Burlington and during 1968 at the tower near the mouth of the Niagara River, have been analyzed. The vertical wind profile up to 12 metres height could be predicted with a simple model to within a standard deviation of 3 per cent. However, investigation reveals that successful models for prediction of vertical air temperature profiles will be more complex.

Instrumentation for 1969 studies, consisting of heated film anemometers, resistance-wire temperature sensor, Lyman $\propto$ hygrometer and Thornthwaite unit parcel momentum flux meters, was assembled for the direct measurement of heat, moisture, and momentum flux over a lake surface from a rigid tower. Periods of observations were conducted to obtain an evaluation of the instrumentation and of the observational techniques. Several days of continuous measurement of the time variation of momentum flux affecting water movements were obtained. Indicated changes in experimental methods will be effected prior to the IFYGL program (1971-72).

MELON (Massive Effort in Lake Ontario) — The 1969 MELON experiments were designed mainly to examine the structure and variability of water movements in the western end of Lake Ontario (Figure 2). Theoretical models of lake circulation have been dominated by the boundary value problem approach, leading to relatively simple mean flow patterns. While it is possible that such motions do exist, an increasing body of evidence indicates that complex, seemingly random, large-scale motion, similar to turbulence, may be more important in determining the movement and ultimate dispersal of any substance in the lakes.

The core of the experiments consisted of arrays of moored self-recording current meters. The distribution of the moorings was chosen so that horizontal and vertical coherence of motion could be tested at a variety of scales. The arrays were maintained during two periods, the first from May 1 to June 27 when the lake progressed from isothermal to weakly stratified conditions, and the second from August 14 to September 21 when the lake was strongly stratified into two layers. Routine monitor cruises involving fixed-point physical and chemical sampling were carried out during and between the current meter experiments. Other experiments relating to air-sea interaction and diffusion, were conducted at the time of the current meter experiments.

Two drogue experiments were conducted during the first MELON experiment. Twelve drogues were tracked for almost four days in late April, and again for one day in early June. A modification of Okubo's (1969) technique for calculating large-scale diffusion coefficients from drogue data was proposed by Hamblin, and has been applied to the experiments. In addition, current-meter data taken in the vicinity of the drogue experiments were obtained to estimate large-scale diffusion parameters. Values for horizontal eddy diffusivity for large-scale turbulence, suitable for physical modelling are given as 5000 $cm^2\ sec^{-1}$ for homogeneous conditions and 10^5 $cm^2 sec^{-1}$ during the strongly stratified conditions.

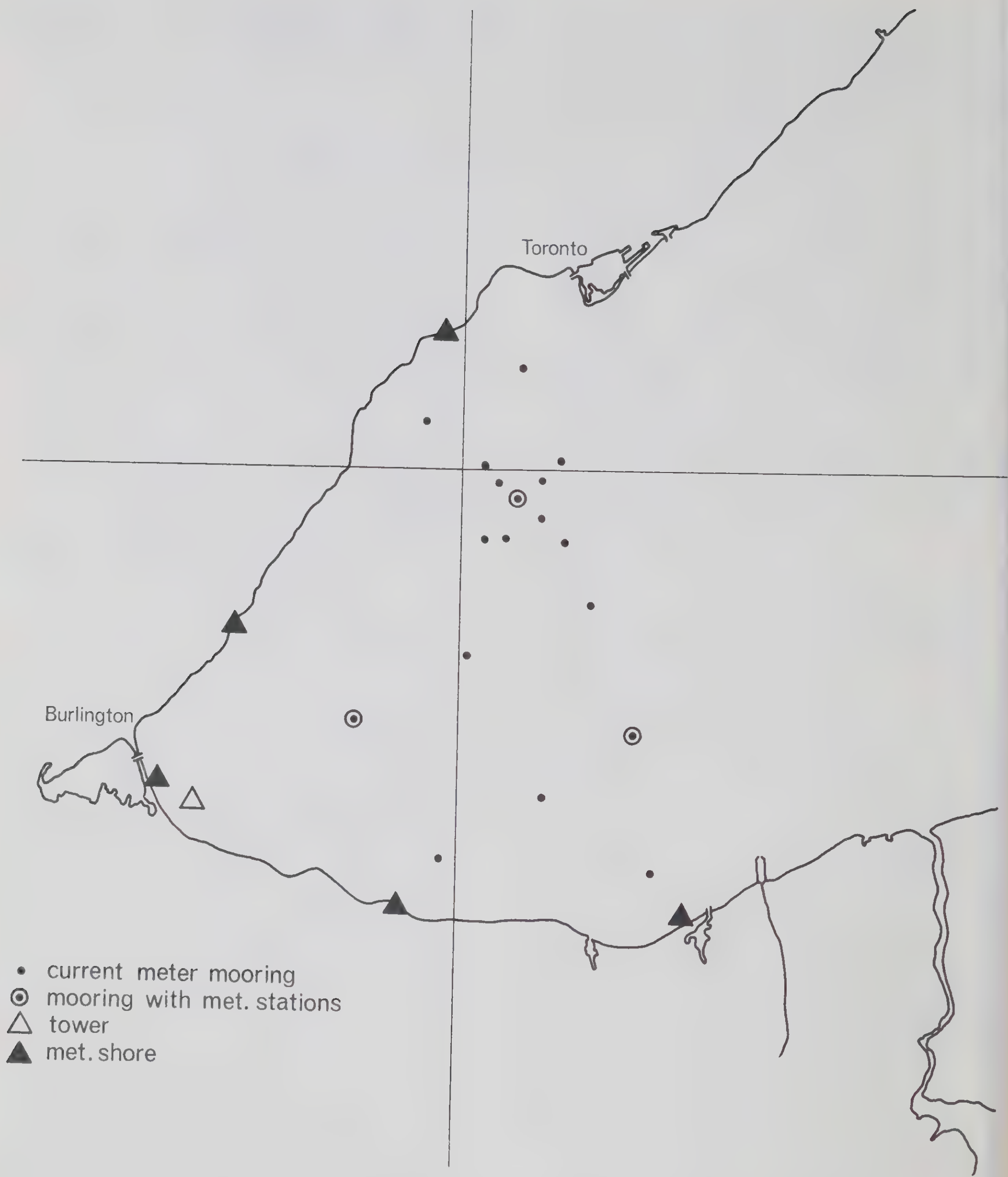


Figure 2. Station locations, MELON I, May 1 – June 27, 1969.

Three dye-patch diffusion experiments, in early May, mid-June and late August, were carried out to study large-scale horizontal diffusion in the upper layers of the open lake under isothermal and stratified conditions. The concentration of dye (Rhodamine B) in the "patch" was measured for about 60 hours using shipborne fluorometers as the diffusion processes caused it to spread out and become more dilute. Airphotos were taken at intervals whil the dye remained visible. Measurements c current and temperature structure were mad simultaneously in order to study the effects o these phenomena on the diffusion. An exampl of horizontal concentration distribution i shown in Figure 3. The ship's tracks alon which continuous recordings of concentratio were made are also indicated. The diffusivitie

omputed from these concentration distributions are typically of the order of $10^4 - 10^5$ $m^2\ sec^{-1}$, two orders of magnitude greater han reported values based on short-term, coninuous dye plume studies.

Extensive measurements of lake currents in he western end of Lake Ontario were made luring each of the two parts of MELON. Initial esults indicate that the currents in the Toronto-Hamilton-Niagara River area were lockwise in nature (confirming earlier studies), nd that the postulated "cellular" nature of the flow may not exist during weak stratification. The prominent counter-clockwise quasi-circular motions of periods of about 17.5 hours (one-half pendulum day) appear primarily when stratification becomes present, indicating that the motions probably are associated with motions near the thermocline. Coherence analyses are continuing.

The area of Lake Ontario west of a Toronto to Niagara line was mapped using 8-13 micron infrared imagery on several closely spaced days during May 1969 (Figure 4). The imagery

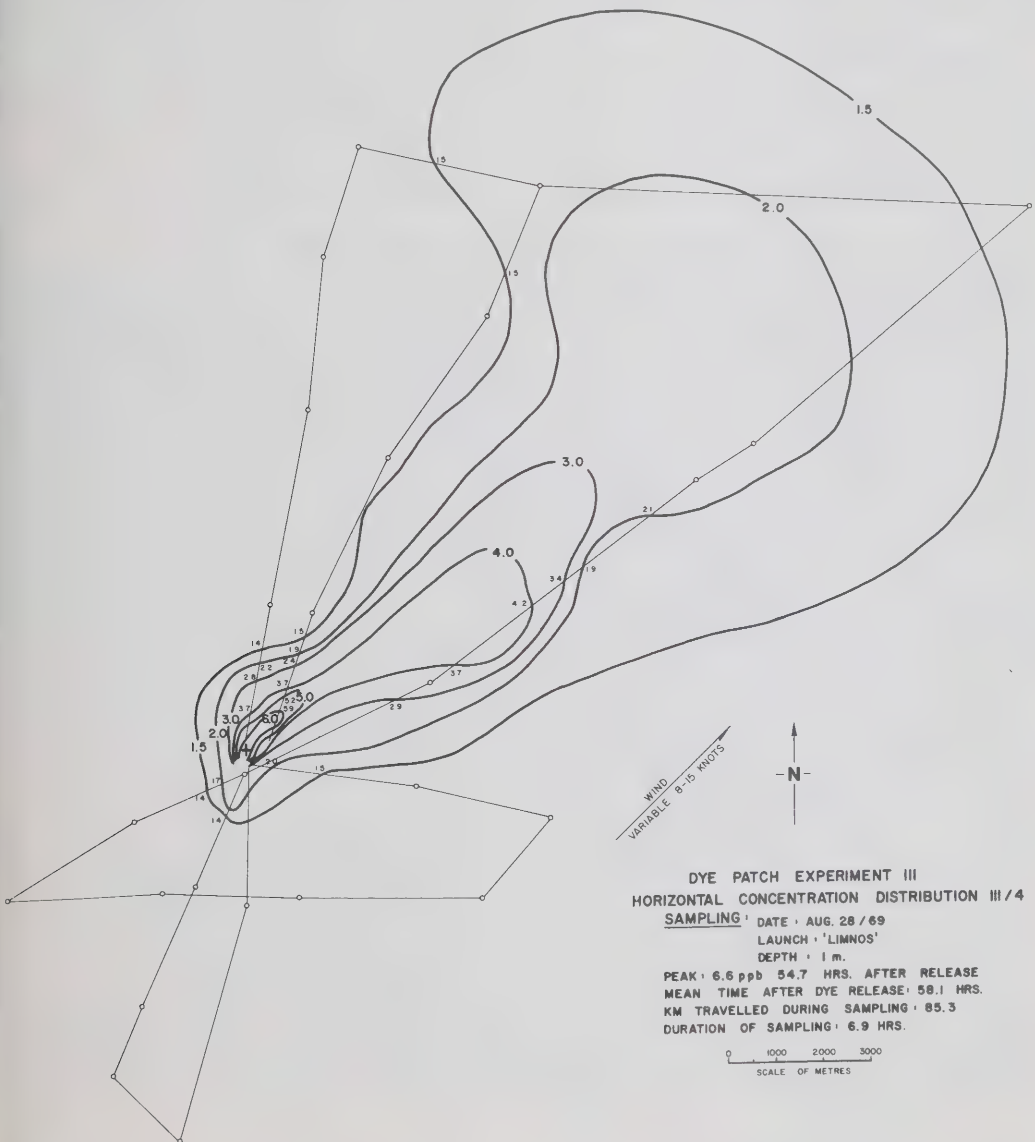


Figure 3. Example of results of dye patch experiment, MELON, 10 km off Port Credit, Ontario.

indicates large temporal and spatial variations of surface temperature over a wide range of scale sizes.

The larger scales show persistence over the days of measurement but the finer scales show large variations between periods, and even within a given day. Examination of the prevailing meteorological conditions on each of the days of observation shows that the fine detail in surface temperature patterns can be related to the local wind plus air-water temperature differences. The effects of variations in solar insolation are less well related.

Remote Sensing — Periodic surveys, mainly of western Lake Ontario, using the modified Singer Reconofax scanner, an airborne thermometer (RT) and various cameras, continued during 1969 (Table I). Data analyzed thus far have been incorporated in the MELON prograr (e.g. Figure 4).

Descriptive Projects — The preparation c an atlas of Great Lakes data continued durin 1969. Summaries in map form of all availabl temperature and dissolved oxygen informatio will be complete by the end of 1970. Bathy thermograph temperature profiles have bee coded and are being keypunched. Temperatur and dissolved-oxygen data are being compute printed onto plots for contouring and gridding Summarization of data at grid points is prc ceeding. Most of the steps completed have bee for CCIW data. Data from the Great Lake Institute, University of Toronto, initially pro cessed by that group, are now being introduce into the atlas charts.

Kenora — In association with the smal lakes eutrophication program of the Fisherie

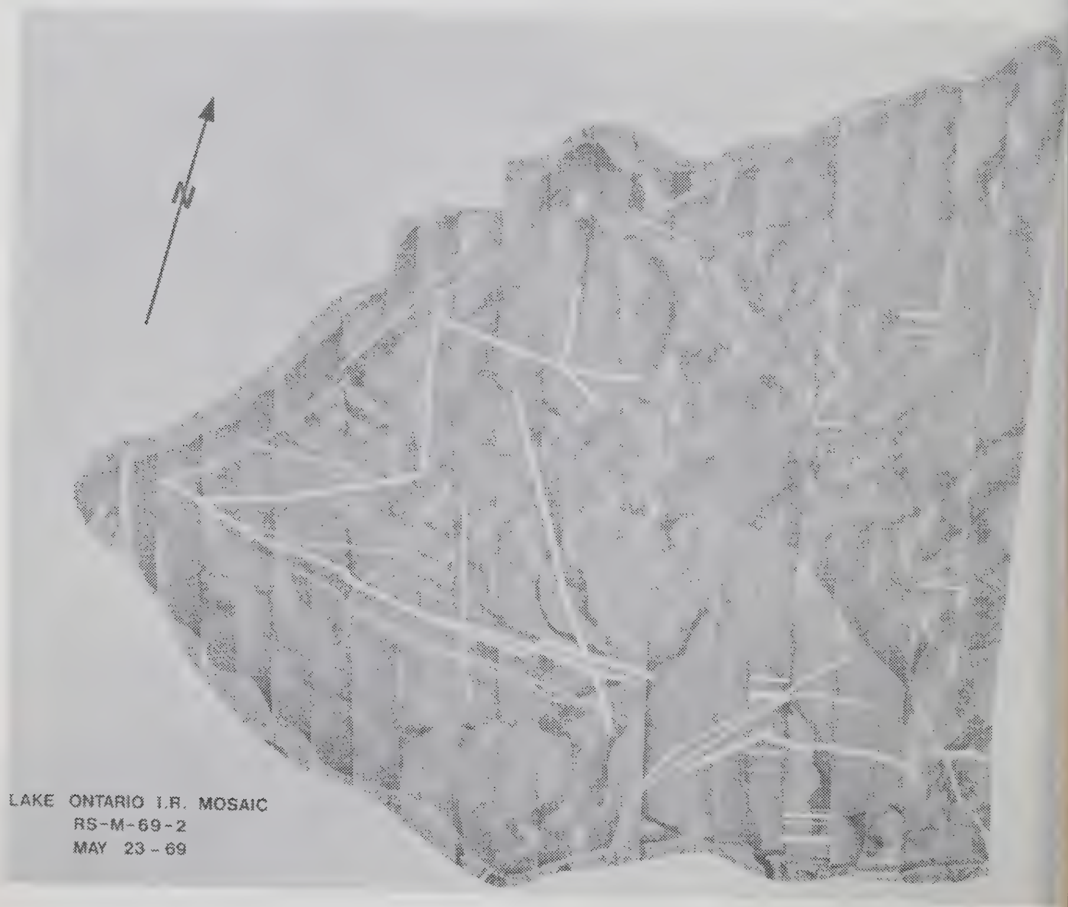


Figure 4. Example of infrared (thermal) imagery, western Lake Ontario (Niagra River mouth, at bottom, right of centre). White strips cover ship tracks.

TABLE I
Infrared Scanner Survey

Date 1969		Location	Altitude (feet)	RT	Air Photos	Comments
May	21	W. Lake Ontario	7,000	yes	35 mm blk & wht MK 7 camera	35 mm photos are poor quality.
	23	W. Lake Ontario	7,000	yes	" "	Hand held Pentox photos successful.
	26	W. Lake Ontario	7,000	yes	" "	
	27	W. Lake Ontario	7,000	yes	" "	
July	8	W. Lake Ontario	7,000	no	35 mm color MK 7 RC8 blk & wht	Scanner breakdown.
	11	W. Lake Ontario	7,000	yes	" "	Terminated — cloudiness.
	14	W. Lake Ontario	7,000	yes	F95 70 mm color F95 70 mm false color	
	15	W. Lake Ontario	7,000	yes	" "	
July	24	Lake Winnipeg	6,000	no	MK 7 35 mm color	RT malfunction.
August	22	W. Lake Ontario	7,000	yes	35 mm color MK 7	MK 7 malfunction.
September	3	W. Lake Ontario	7,000	yes	35 mm color MK 7 RC8 color	
	3	Lakeview Power Generating Station	1,500	yes	35 mm color MK 7 RC8 color	
	8	W. Lake Ontario	7,000	yes	35 mm color	Terminated — cloudiness.
December	5	E. Lake Ontario	500–1,000	yes	nil	Special tests over *MV Martin Karlsen* off Oswego.

Research Board, near Kenora, Ont., studies of lake hydrology were undertaken by Inland Waters Branch, Meteorological Branch (DOT), and the University of Manitoba. In collaboration with the Engineering Systems Section, the Physical Limnology Section established and maintained a tower instrumented to record standard meteorological parameters, as well as incoming, reflected, and diffuse solar radiation, and net total radiation over one of the major lakes (Figure 5). Data have been provided for heat and water budget computations.

Instrument Development Work — During 1969 the Physical Limnology Section has been involved, with the assistance and collaboration of the Engineering Systems Section, in the design and development of instruments. The most substantial project involved a towed thermistor array intended to give continuous temperature profiles in the upper 30-40 metres of water while being towed from a moving ship. Encapsulated thermistors plug into 13 breakouts located at intervals along a faired cable, which incorporates both electrical conductors and strength members. The free end of the cable is held down by a depressor fin which also houses a pressure sensor. The upper end terminates mechanically in a specially designed winch. A digital data acquisition system has been acquired for the array which is capable of sampling up to 20 channels 10 times/second.

The Bedford Institute of Oceanography has developed a towed undulating body capable of carrying a variety of sensors. A prototype of this body carrying temperature and depth sensors was tested in Lake Ontario in July 1969. The trials were conducted jointly between the Bedford Institute of Oceanography and CCIW (Technical Operations Section and Physical Limnology Section). The system was found to have useful applications to Great Lakes work. Further trials of an improved system will be held during the 1970 field season.

Other instrument development work has been undertaken on a moored, self-recording

temperature profiler device to measure near-surface temperature profiles and drogues.

Modelling – A steady state model of hydraulically induced circulation in a rotating homogeneous circular lake was prepared. Numerical solutions, based on assumptions of constant lateral and vertical eddy diffusivity coefficients, were obtained for conditions of constant depth, for a parabolic basin, and for conditions of uniform wind stress.

Applications of simple statistical models to nearshore current measurements (within about 10 km from shore) show that prediction of such currents from winds measured on shore, shows some promise. The models also show sensitivity to averaging periods in reducing the data. Investigation, testing and evaluating of such models are continuing.

Oil Pollution – A member of the Section undertook during 1969, to review current methods of combatting massive oil pollution. A visit was made to Santa Barbara, Calif. i February 1969 to observe the effects of the o spill there and to study the techniques used t clean up the oil.

Contracted Research

Department of Mechanical Engineerin University of Waterloo – During 1969, a fiel study of the predicted "coastal jet" phenom non, was provided with funds. Measurements c current profiles (speed, direction, temperatur were made offshore in Lake Ontario, ne Oshawa. Results indicated that the curren patterns were quite complex, and that tim series measurements would have to be made i conjunction with the measurements made ov space and time, in order to fully evaluate th significance of the observed patterns. Co tinued support for this program is planned fc 1970.

H.G. Acres Co. Ltd. – A survey of th magnitudes and locations of present thermal ir

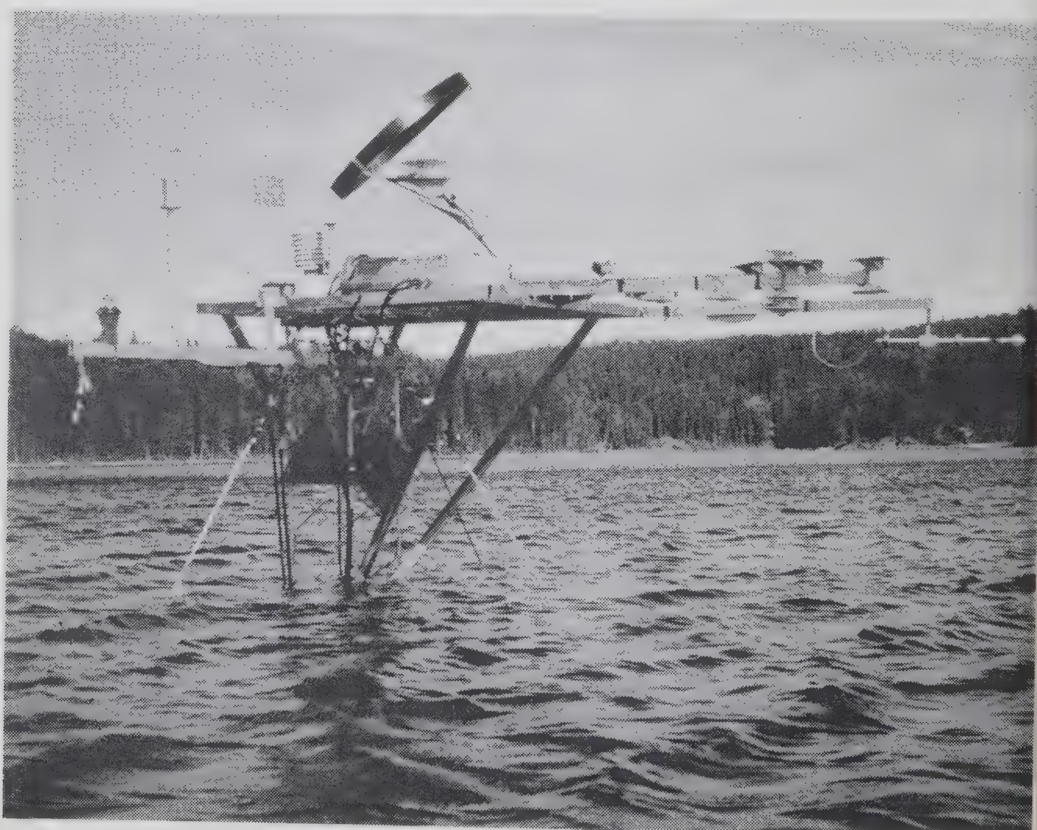


Figure 5. Radiation tower in Lake 239, near Kenora, Ontario.

puts to the Great Lakes and a projection of these inputs to the year 2000 has been completed through contract with the H.G. Acres Co. Ltd. The present total input to the Great Lakes is estimated to be about 10^{10} Btu/hr. This input is expected to increase by greater than an order of magnitude by the year 2000.

A simple model employing an "equilibrium surface temperature" approach has been applied to arrive at estimates of lake temperature that can be expected as a result of the increased thermal input. Results of this part of the study are not conclusive at this time.

H.G. Acres Co. Ltd. — Inland Waters Branch sponsored a study of requirements for ice research in Canada and the Great Lakes Division participated in support and monitoring of the program. The study is providing summaries of the state of present knowledge and recommendations for priorities for future ice research efforts.

Geography Department, McMaster University — A study was undertaken, under contract, to measure incoming, reflected and diffuse solar radiation and net total radiation at a nearshore tower adjacent to Grimsby on Lake Ontario. Analyses are proceeding and will include evaluations of empirical techniques for estimating radiation values, measurement procedures, and estimates of emissivity values under varying lake conditions.

Great Lakes Institute, University of Toronto — Several studies, including the provision of limnological data in support of MELON, thermal bar studies, and data atlas developmental work, were performed during 1969, under contract.

Limnogeology Section

The Limnogeology Section is responsible for undertaking two different, though interrelated types of research on the bottom sediments and suspended particulate matter of major Canadian lakes. In one, inventory data is obtained which will permit categorizing and plotting of distribution maps and diagrams, to show, for example, what types of material are present in the lake sediments, how much material there is and where it occurs.

The second line of research is related to process studies. Included under this heading, for example, are studies of the physical problems of erosion, transportation and deposition of sediments and the organic and inorganic chemical processes involved in sediment diagenesis and authigenesis, and the various geobiological interactions involved between the sediments and the biota. Of particular importance are exchanges of phosphates and other nutrients and micronutrients between the sediments and the overlying waters.

1. In a sediment inventory study along the north shore of Lake Ontario, bottom samples were collected on a 2-km grid, and echo soundings and transit sonar surveys were made perpendicular to the shore at 2-km intervals. Much of the nearshore zone, between Whitby and Wellington is floored by glacial sediments and bedrock. Glacial materials and lag deposits predominate in the area west of Colbourne, and bedrock to the east.

Throughout most of the area, unconsolidated sediments occur as a thin discontinuous wedge adjacent to the shoreline, widening locally in the vicinity of creek and harbor entrances. In the area immediately east and west of the peninsula, however, sediment does cover a major part of the nearshore zone, mostly as sand or silty sand. The concentration of sediment in the eastern part of the nearshore zone and the consistent accumulation of sediment on the west side of shore structures indicates that the net sediment drift is from west to east. The dividing zone between eastward and westward shore region drift appears to occur between Frenchman Bay and Whitby along the north shore of Lake Ontario.

Figure 6 shows the distribution of various bedrock and unconsolidated deposits, west along the shoreline, between Whitby and Niagara. This summarizes results of the field survey in 1968.

2. About 560 bottom samples and cores have been taken during 1969 in the areas selected for statistical sampling. One of these is in the heavily polluted Niagara River mouth area and the other in the relatively clean Georgian Bay–Bruce Peninsula region. Sedimentological, geochemical, and biological analyses (courtesy Fisheries Research Board) are now partly completed. In Georgian Bay, very low rates of deposition are evident in much of

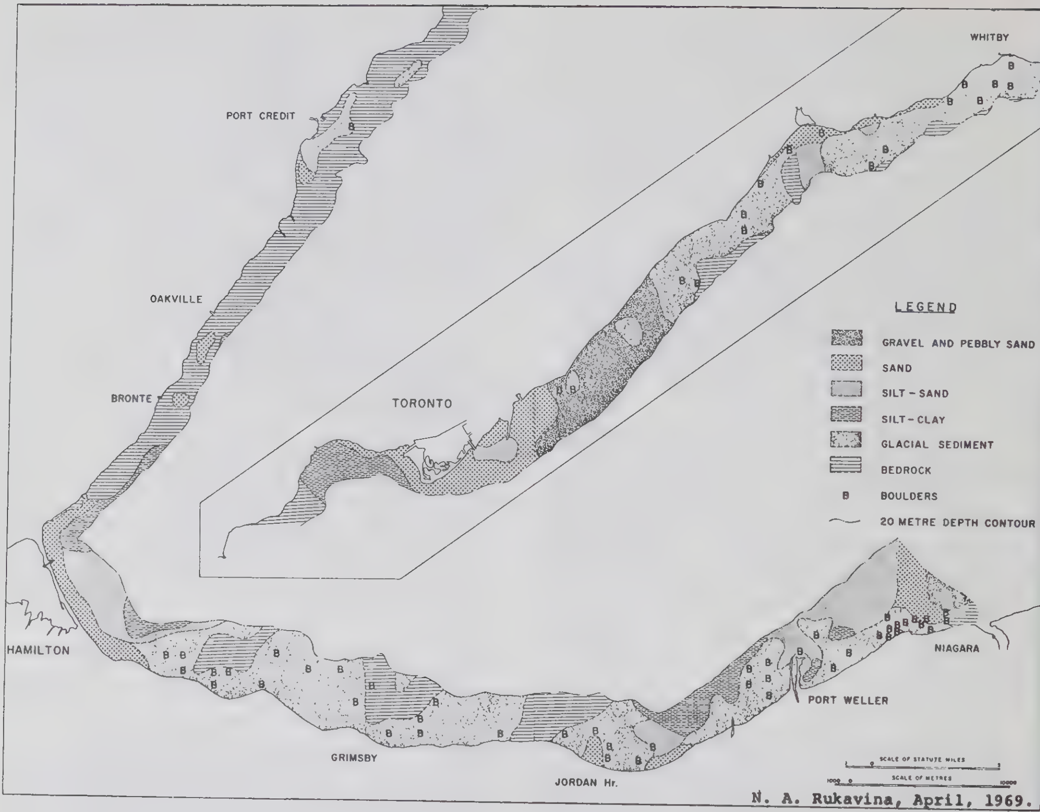


Figure 6. Distribution of various bedrock and unconsolidated deposits, west along the shoreline, between Whitby and Niagara.

the study area, Holocene deposits often being only a few centimetres thick (Figure 7). There are, however, thicknesses of more than 2 metres in the deepest parts. The Holocene deposits overlie glaciolacustrine sediments which are considerably more than 30 metres thick in several places. In the Niagara area of Lake Ontario, the high energy environment of the nearshore zone is typified by a thin and discontinuous cover of sands and silty sands which overlie bedrock and glacial till. Sampling in these two contrasting areas will provide valuable information for guidance of "process" studies on the spatial variations of physical, chemical and biological parameters within the sediments.

3. In the area of Lake Ontario between Hamilton and Toronto, variations in the textural and mineralogical characteristics of sandy sediments were used as natural traces to determine the net direction of transport and the provenance of near-shore sand deposits. Trials were also conducted in the same area using artificial fluorescent sand tracers. The lake shoreline appears to be a prime source of the materials found. Fluorescent tracers deposited at three locations indicate that the sediment movement is not consistent throughout the area.

4. Paleoecological studies have been restricted largely to an area at the west end of Prince Edward Bay, in Lake Ontario. Here chironomids were taken from samples of bottom sediments and also, in specially designed traps as they hatched. The prime objective has been to capture a number of different species and to rear them for morphological observations and identification at different stages in the life cycle. Additional material for chironomid studies was also obtained from the western end of Lake Erie and from the western part of Georgian Bay. However, the particularly

gh population counts of chironomids observed both in Prince Edward Bay and in e western Georgian Bay area are of note. hironomid distribution is related to the egree of pollution of the sediments and n, it is hoped, be used as indicator organisms. his program received substantial biological uidance and support from Fisheries Research oard Staff.

5. Detailed continuous profiling surveys ere run over much of the western basin of ake Erie, using a boomer source. These were ontrolled by sediment cores taken at selected ations. The profiling was specifically designed r shallow penetration to provide a better nderstanding of the complex stratigraphy of e unconsolidated deposits. This is a continuaon of earlier work by the Geological Survey of anada.

6. During the summer of 1969, the *CSS imnos* undertook a seven-week sediment reonnaissance cruise in Lake Huron. Over 7,000 autical miles of survey line were covered using cho sounding, side scan sonar, and air-gun eismic reflection profiling. In addition, bottom ediments were sampled at 196 stations for geochemical and sedimentological analysis. Sediment distribution in Lake Huron is extremely complex and is mostly controlled by the solid geology of the region, which also controls much of the relief.

The lithology of the near-shore zone of the lake is variable, with complex interrelationships between gravel, bedrock, glacial clays and tills, and sands (which frequently occur as rippled streamers or ribbons over glacial surfaces).

In addition to these major surveys several smaller projects were undertaken.

1. In the early part of the summer, a team of divers undertook a preliminary evaluation of underwater sampling, and survey operations, using an underwater habitat. The site location was at Little Dunk's Bay near Tobermory on the Bruce Peninsula, and operations were conducted at the Sub-Limnos Habitat of Dr. J. McInnes. Because of several unfortunate setbacks, particularly the lack of on-site power, the operations using the habitat were not fully successful. Further evaluation will be necessary before the value of habitat techniques can be properly assessed.

Figure 7. Angular gravel fragments on the lake floor in Georgian Bay, east of Bears Rump Island in 42 metres of water. Underwater compass on right.

2. During the late summer, a cooperative program was undertaken with members of the Fisheries Research Board, Freshwater Institute, on Lake Winnipeg. Here comparative tests were made using different bottom sampling and coring devices to determine the most efficient equipment for obtaining biological, and geological materials. In addition, further assistance was afforded to the University of Manitoba in connection with a preliminary survey of the geology of Lake Winnipeg.

Contract Study – The Department of Geology of Lakehead University undertook a survey by contract of the near-shore zone of Lake Superior. Sampling equipment, a small boat with outboard motor, and some field training were provided by CCIW, and arrangements were made through the good offices of the University of Michigan for the use of the research vessel, *Inland Seas*. Surveys started at the southeastern end of the lake and were extended as far north as Michipicoten Harbour on the Canadian shore. Studies involved observations and sampling of shoreline material, detailed sampling and echo sounding in the near-shore zone, and some control sampling and coring, and echo sounding in the offshore areas. One particularly important observation from the results so far available is that the sand deposits in the near-shore zone rarely extend to depths greater than 5 metres, rapidly giving way to silts and silty muds in deeper water. This may suggest that the high energy environment associated with wave action in the near-shore zone of this particular part of Lake Superior is restricted to areas where water depth is some 5 metres or less. This is a little surprising since the sand area appears to be similarly depth-controlled in Lake Ontario, where wave energy and fetch are expected to be generally less.

Laboratory Operations – The laboratories of the Section have continued to develop methods for quantitative and qualitative geochemical and sedimentological analyses of sample material. The sedimentology laboratory processed 20 short pipet analyses; 55 1-phi sieve analyses; 70, $^1/_4$-phi sieve analyses, and has made up some 550 slides for clay X-ray analyses. In addition, it has completed 60 carbonate determinations and 150 heavy mi eral separations.

Unfortunately, due to a breakdown in th X-radiography unit, only a few cores have bee logged so far by radiography. It is hope however, to have the system in operation agai in the near future. The use of sedimentatio tubes for rapid sand analysis has been tem porarily abandoned because of problems wit the recording equipment. The inorganic geo chemistry laboratory has completed some 50 dry analyses and about 3,100 wet analyse Among the substances analyzed were: tota quartz, total clay, clay minerals, Al_2O_3, K_2O Na_2O, CaO, MgO, P_2O_5, TiO_2, MnO, FeO Fe_2O_3, Ca, Zn, Pb, and N.

The organic geochemistry laboratory has s far completed about 1,500 dry analyses, 3 chromatographic analyses, and about 400 ex tractions and wet analyses. Most of the wor involved analysis of: organic carbon, inorgani carbon, nitrogen, extractable phosphate, ni trate, ammonium, chlorophylls and their degra dation products, humic and fulvic acids bitumens and kirogens.

Technical Operations Section

Major Ships – Two major ships, the *CS Limnos* and the charter vessel *MV Marti Karlsen*, were used for Great Lakes monitorin and scientific data collection in 1969.

The *CSS Limnos* is owned by the Depart ment of Energy, Mines and Resources an operated by the Marine Sciences Branch During the field season many varied cruises using a variety of scientific equipment, wer carried out. These included a two-month ex tensive limnogeological survey of Lake Huron, type of work for which *Limnos* is particularl suited. Unfortunately, mechanical problem have continued to plague the ship, necessitatin a stay in drydock and the cancellation o several cruises. Late season work was extende because of stormy weather conditions, parti cularly on the upper lakes.

The *MV Martin Karlsen* (Figure 8) wa chartered in April 1969 for three years with a option for a further two years. Before leavin Halifax, the vessel was fitted out with a dec house, laboratory, oceanographic winch an sampling platform, and laboratory in th

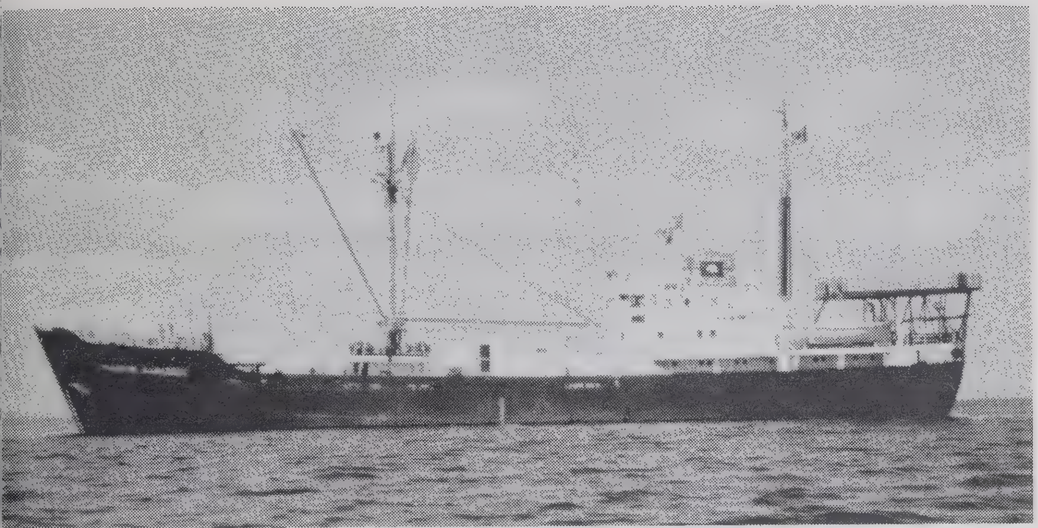


Figure 8. Chartered vessel *MV Martin Karlsen.*

-tween-deck area. She arrived at CCIW on pril 22, 1969 and after the installation of ientific equipment, commenced regular operaons on April 28, 1969. Greater emphasis was aced on monitoring cruises on *Karlsen* as the commodation and laboratory space were eal for this type of operation. However, other pes of cruises were also performed successlly.

Personnel from Technical Operations were signed to both the major ships on a continug basis throughout the season. Scientific ersonnel from other agencies joined vessels in cordance with prearranged schedules coordiated by the Technical Operations Section.

Technical Operations personnel were reonsible for all deck observations (sampling, easurements, recording of physical paraeters, mooring, coring and manual chemistry).

Routine meteorological observations and ports were also carried out by this group, and ansmitted regularly to Meteorological Branch recast centres.

SK-5 Hovercraft — During February a survey was carried out in the eastern basin of Lake Erie using an SK-5 hovercraft (Figure 9) chartered from Bell Aerosystems, Buffalo, to evaluate the usefulness of such a craft as a survey vehicle on icy lakes in winter. Operations commenced on February 6, and finished on February 28 with a total of $46^1/_4$ hours flying-time.

The hovercraft was accompanied by a DOT Bell Jet Ranger helicopter. During the period of operation, 16 stations were occupied, 14 on ice and 2 on open water. But the use of an SK-5 hovercraft was found to be not practicable at present for CCIW purposes on Lake Erie, primarily because of the height of ridges in the ice and onboard space limitations together with logistic difficulties.

Small Craft — The Technical Operations Section continued to coordinate the assignment of the fleet of CCIW small craft to various sections at CCIW and to outside agencies.

OPERATIONAL TABLE 1969

Ship	Started Operations	Completed Operations	Miles Steamed	Total Days	Away on Operations	Per cent
CSS Limnos	March 31	December 18	16,944	263	152	58
MV Martin Karlsen	April 28	December 6	21,620	223	173	77

(complete schedules are given in Tables II and III)

TABLE II

1969 Great Lakes Studies – *CSS Limnos*

	SUN	MON	TUE	WED	THU	FRI	SAT
	30 CCIW	31 DEP CCIW 1020 MOORING L. ONT.	1 ARRIVE CCIW 1305 HRS	2 CCIW	3 CCIW	4 CCIW	5 CCIW
APRIL	6 CCIW	7 CCIW	8 DEPART CCIW 0813 HRS	9 MOORING LAKE ERIE	10 ARRIVE CCIW 1625 HRS	11 CCIW	12 DEPART CCIW 0800 HRS
	13 MONITOR LAKE ONTARIO	14 MONITOR LAKE ONTARIO	15 MONITOR LAKE ONTARIO	16 ARRIVE CCIW 1410 HRS	17 CCIW	18 CCIW	19 CCIW
	20 CCIW	21 CCIW	22 CCIW	23 CCIW	24 DEPART CCIW 1000 HRS	25 MOORING LAKE ONTARIO	26 MOORING LAKE ONTARIO
	27 MOORING LAKE ONTARIO	28 MOORING LAKE ONTARIO	29 MOORING LAKE ONTARIO	30 MOORING LAKE ONTARIO	1 ARRIVE CCIW 1800 HRS	2 CCIW	3 CCIW
	4 DEPART CCIW FOR PORT WELLER	5 PORT WELLER	6 PORT WELLER	7 PORT WELLER	8 PORT WELLER	9 PORT WELLER	10 PORT WELLER
MAY	11 PORT WELLER	12 PORT WELLER	13 PORT WELLER	14 PORT WELLER	15 PORT WELLER	16 PORT WELLER	17 PORT WELLER
	18 PORT WELLER	19 PORT WELLER	20 PORT WELLER	21 PORT WELLER	22 PORT WELLER	23 PORT WELLER	24 PORT WELLER
	25 PORT WELLER	26 ARRIVE CCIW 2000 HRS	27 CCIW	28 DEPART CCIW 1225 HRS	29 MOORING LAKE ONTARIO	30 MOORING LAKE ONTARIO	31 MOORING LAKE ONTARIO
	1 MOORING LAKE ONTARIO	2 ARRIVE CCIW 1220 HRS	3 DEPART CCIW 0905 MELON MONITOR	4 ARRIVE CCIW 1403 MELON MONITOR	5 CCIW	6 CCIW	7 CCIW
JUNE	8 CCIW	9 DEPART CCIW 0905 HRS	10 LIMNOGEOLOGY LAKE ERIE	11 LIMNOGEOLOGY LAKE ERIE	12 ARRIVE SARNIA 1530 HRS	13 SARNIA	14 DEP SARNIA 0138 HRS
	15 LIMNOGEOLOGY LAKE HURON	16 LIMNOGEOLOGY LAKE HURON	17 LIMNOGEOLOGY LAKE HURON	18 LIMNOGEOLOGY LAKE HURON	19 LIMNOGEOLOGY LAKE HURON	20 LIMNOGEOLOGY LAKE HURON	21 ARR GODERICH 1530 HRS
	22 DEP GODERICH 0800 HRS	23 LIMNOGEOLOGY LAKE HURON	24 LIMNOGEOLOGY LAKE HURON	25 LIMNOGEOLOGY LAKE HURON	26 LIMNOGEOLOGY LAKE HURON	27 LIMNOGEOLOGY LAKE HURON	28 ARR OWEN SOUND 1535 HRS
	29 OWEN SOUND	30 DEP OWEN SOUND 0830 HRS	1 LIMNOGEOLOGY LAKE HURON	2 LIMNOGEOLOGY LAKE HURON	3 LIMNOGEOLOGY LAKE HURON	4 LIMNOGEOLOGY LAKE HURON	5 LIMNOGEOLOGY LAKE HURON
JULY	6 LIMNOGEOLOGY LAKE HURON	7 LIMNOGEOLOGY LAKE HURON	8 LIMNOGEOLOGY LAKE HURON	9 LIMNOGEOLOGY LAKE HURON	10 LIMNOGEOLOGY LAKE HURON	11 ARR OWEN SOUND 1440 HRS	12 OWEN SOUND
	13 OWEN SOUND	14 DEP OWEN SOUND 2145 HRS	15 LIMNOGEOLOGY LAKE HURON	16 LIMNOGEOLOGY LAKE HURON	17 LIMNOGEOLOGY LAKE HURON	18 OWEN SOUND 1210 - 1700	19 LIMNOGEOLOGY LAKE HURON
	20 LIMNOGEOLOGY LAKE HURON	21 LIMNOGEOLOGY LAKE HURON	22 LIMNOGEOLOGY LAKE HURON	23 LIMNOGEOLOGY LAKE HURON	24 LIMNOGEOLOGY LAKE HURON	25 LIMNOGEOLOGY LAKE HURON	26 LIMNOGEOLOGY LAKE HURON
	27 ARR SARNIA 1110 DEP SARNIA 1400	28 IN TRANSIT	29 ARRIVE CCIW 0800 HRS	30 CCIW	31 CCIW	1 CCIW	2 CCIW
	3 CCIW	4 CCIW	5 DEPART CCIW 1440 HRS	6 MELON PROJECT LAKE ONTARIO	7 MELON PROJECT LAKE ONTARIO	8 ARRIVE CCIW 0045 HRS	9 CCIW
AUG	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 DEPART CCIW 1150 HRS	15 MOORING LAKE ONTARIO	16 MOORING LAKE ONTARIO
	17 MOORING LAKE ONTARIO	18 ARRIVE CCIW 1845 HRS	19 CCIW	20 CCIW	21 DEP CCIW 0933 MELON MONITOR	22 ARR CCIW 1611 MELON MONITOR	23 CCIW
	24 CCIW	25 DEPART CCIW 1810 HRS	26 DYE PATCH DIF. LAKE ONTARIO	27 DYE PATCH DIF. LAKE ONTARIO	28 DYE PATCH DIF. LAKE ONTARIO	29 ARRIVE CCIW 1800 HRS	30 CCIW
	31 CCIW	1 CCIW	2 CCIW	3 CCIW	4 DEPART CCIW 0600 HRS	5 SURFACE TEMP. LAKE ONTARIO	6 ARRIVE CCIW 1615 HRS
	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
SEPT	14 CCIW	15 CCIW	16 CCIW	17 DEPART CCIW 0000 HRS	18 MOORING LAKE ONTARIO	19 ARRIVE CCIW 1605 HRS	20 CCIW
	21 CCIW	22 DEPART CCIW 1910 HRS	23 GRAVITY LAKE ONTARIO	24 GRAVITY LAKE ONTARIO	25 ARRIVE CCIW 1125 HRS	26 CCIW	27 CCIW
	28 CCIW	29 DEPART CCIW 1200 HRS	30 GRAVITY LAKE ERIE	1 GRAVITY LAKE ERIE	2 GRAVITY LAKE ERIE	3 ARR LEAMINGTON 1920 HRS	4 LEAMINGTON
	5 DEP LEAMINGTON 0620 HRS	6 GRAVITY LAKE ERIE	7 ARRIVE CCIW 2100 HRS	8 CCIW	9 CCIW	10 CCIW	11 CCIW
OCT	12 CCIW	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 CCIW
	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW
	26 CCIW	27 DEPART CCIW 1555 FOR L. SUPERIOR	28 IN TRANSIT	29 IN TRANSIT	30 ARR SAULT STE. MARIE 0600 HRS	31 DEP SOO 0800 LAKE SUPERIOR	1 IN TRANSIT FOR CCIW
	2 ARR SARNIA 1400 HRS	3 DEP SARNIA 0700 HRS	4 IN TRANSIT	5 ARRIVE CCIW 0600 HRS	6 DEPART CCIW FOR PORT WELLER	7 PORT WELLER	8 PORT WELLER
NOV	9 PORT WELLER	10 PORT WELLER	11 PORT WELLER	12 PORT WELLER	13 PORT WELLER	14 PORT WELLER	15 PORT WELLER
	16 ARRIVE CCIW 1000 HRS	17 CCIW	18 DEP CCIW 0910 FOR LAKE HURON	19 IN TRANSIT LAKE ERIE	20 IN TRANSIT LAKE ERIE	21 IN TRANSIT LAKE ERIE	22 MONITOR LAKE HURON
	23 MONITOR LAKE HURON	24 MONITOR LAKE HURON	25 MONITOR LAKE HURON	26 MONITOR LAKE HURON	27 MONITOR LAKE HURON	28 ARR OWEN SOUND 0845 HRS	29 DEP OWEN SOUND 0800 HRS
	30 MONITOR LAKE HURON	1 MONITOR LAKE HURON	2 MONITOR LAKE HURON	3 MONITOR LAKE HURON	4 MONITOR LAKE HURON	5 ARR SARNIA 1700 DEP SARNIA 1830	6 ARR WINDSOR 1006 HRS
DEC	7 DEP WINDSOR 1000 HRS	8 MONITOR LAKE ERIE	9 MONITOR LAKE ERIE	10 MONITOR LAKE ERIE	11 MONITOR LAKE ERIE	12 MONITOR LAKE ERIE	13 ARR CCIW 0900 HRS
	14 CCIW	15 CCIW	16 DEP CCIW 0900 HRS	17 MOORING LAKE ONTARIO	18 ARRIVE CCIW 1345 HRS	19 END OF	20 FIELD SEASON

TABLE III

1969 Great Lakes Studies *MV Martin Karlsen*

	SUN	MON	TUE	WED	THU	FRI	SAT
	30	31	1 ON CHARTER HALIFAX 0800	2 FITTING OUT	3 FITTING OUT	4 FITTING OUT	5 HALIFAX
APRIL	6 HALIFAX	7 FITTING OUT	8 FITTING OUT	9 FITTING OUT	10 FITTING OUT	11 FITTING OUT	12 HALIFAX
	13 HALIFAX	14 FITTING OUT	15 DEP HALIFAX 2000 HRS	16 ON PASSAGE	17 ON PASSAGE	18 ON PASSAGE	19 ON PASSAGE
	20 ON PASSAGE	21 ON PASSAGE	22 ARR CCIW 0630 HRS	23 CCIW	24 CCIW	25 CCIW	26 CCIW
	27 CCIW	28 DEP CCIW 1300 LAKE ONTARIO	29 MOORING LAKE ONTARIO	30 ARR CCIW 1830	1 DEP CCIW 0930 MELON MONITOR	2 ARR CCIW 1900 MELON MONITOR	3 CCIW
	4 DEP CCIW 0900 HRS	5 MELON PROJECT LAKE ONTARIO	6 MELON PROJECT LAKE ONTARIO	7 MELON PROJECT LAKE ONTARIO	8 MELON PROJECT LAKE ONTARIO	9 ARR CCIW 1520 HRS	10 CCIW
MAY	11 CCIW	12 DEP CCIW 1300 HRS	13 MONITOR LAKE ONTARIO	14 MONITOR LAKE ONTARIO	15 MONITOR LAKE ONTARIO	16 MONITOR LAKE ONTARIO	17 MONITOR LAKE ONTARIO
	18 ARRIVE CCIW 1200 HRS.	19 CCIW	20 DEPART CCIW 1100 MELON PROJECT	21 MELON PROJECT LAKE ONTARIO	22 MELON PROJECT LAKE ONTARIO	23 MELON PROJECT LAKE ONTARIO	24 MELON PROJECT LAKE ONTARIO
	25 MELON PROJECT LAKE ONTARIO	26 MELON PROJECT LAKE ONTARIO	27 ARRIVE CCIW 2100 HRS.	28 CCIW	29 DEPART CCIW 1000 HRS.	30 MONITOR LAKE ERIE	31 MONITOR LAKE ERIE
	1 MONITOR LAKE ERIE	2 MONITOR LAKE ERIE	3 MONITOR LAKE ERIE	4 MONITOR LAKE ERIE	5 ARRIVE CCIW 0800 HRS.	6 CCIW	7 CCIW
	8 CCIW	9 DEPART CCIW 0900 HRS.	10 MONITOR LAKE ONTARIO	11 MONITOR LAKE ONTARIO	12 MONITOR LAKE ONTARIO	13 MONITOR LAKE ONTARIO	14 ARRIVE CCIW 1800 HRS.
JUNE	15 CCIW	16 DEPART CCIW 1000 HRS.	17 MELON PROJECT LAKE ONTARIO	18 MELON PROJECT LAKE ONTARIO	19 ARRIVE CCIW 1430 HRS.	20 DEPART CCIW 0900 MELON MONITOR	21 ARRIVE CCIW 1600 HRS.
	22 CCIW	23 DEPART CCIW 0930 MELON MOORINGS	24 ARRIVE CCIW 2100 HRS.	25 CCIW	26 DEPART CCIW 0900 ARRIVE CCIW 2100	27 CCIW	28 CCIW
	29 CCIW	30 CCIW	1 CCIW	2 DEPART CCIW 0900 HRS.	3 TEMP. SURVEY LAKE ERIE	4 TEMP. SURVEY LAKE ERIE	5 TEMP. SURVEY LAKE ERIE
	6 TEMP. SURVEY LAKE ERIE	7 ARRIVE CCIW 1000 HRS.	8 DEPART CCIW 1000 HRS.	9 MONITOR LAKE ONTARIO	10 MONITOR LAKE ONTARIO	11 MONITOR LAKE ONTARIO	12 MONITOR LAKE ONTARIO
JULY	13 ARRIVE CCIW 1800 HRS.	14 CCIW	15 CCIW	16 DEPART CCIW 1035 HRS.	17 FIELD TESTS LAKE ONTARIO	18 FIELD TESTS LAKE ONTARIO	19 ARRIVE CCIW 1600 HRS.
	20 CCIW	21 DEPART CCIW 1215 HRS.	22 FIELD TESTS LAKE ONTARIO	23 FIELD TESTS LAKE ONTARIO	24 ARRIVE CCIW 1540 HRS.	25 CCIW	26 CCIW
	27 CCIW	28 DEPART CCIW 0930 HRS.	29 COOT-MONITOR LAKE ERIE	30 COOT-MONITOR LAKE ERIE	31 COOT-MONITOR LAKE ERIE	1 COOT-MONITOR LAKE ERIE	2 ARRIVE CCIW 1000 HRS
	3 CCIW	4 CCIW	5 DEPART CCIW 1100 HRS	6 MONITOR LAKE ONTARIO	7 MONITOR LAKE ONTARIO	8 MONITOR LAKE ONTARIO	9 MONITOR LAKE ONTARIO
AUG	10 ARRIVE CCIW 0950 HRS	11 CCIW	12 DEPART CCIW 0950 HRS	13 CORING LAKE ONTARIO	14 CORING LAKE ONTARIO	15 CORING LAKE ONTARIO	16 ARRIVE CCIW 1130 HRS
	17 CCIW	18 DEPART CCIW 0928 HRS	19 CORING LAKE ERIE	20 CORING LAKE ERIE	21 CORING LAKE ERIE	22 ARR P. COLBORNE 1200 HRS	23 P. COLBORNE
	24 P. COLBORNE	25 DEP. P. COLBORNE 1210 HRS	26 COOT-MONITOR LAKE ERIE	27 COOT-MONITOR LAKE ERIE	28 COOT-MONITOR LAKE ERIE	29 COOT-MONITOR LAKE ERIE	30 ARRIVE CCIW 0720 HRS
	31 CCIW	1 CCIW	2 CCIW	3 CCIW	4 DEPART CCIW 1200 HRS	5 MONITOR LAKE ONTARIO	6 MONITOR LAKE ONTARIO
	7 MONITOR LAKE ONTARIO	8 MONITOR LAKE ONTARIO	9 MONITOR LAKE ONTARIO	10 ARRIVE CCIW 1045 HRS	11 CCIW	12 CCIW	13 DEPART CCIW 0800
SEPT	14 MONITOR LAKE ERIE	15 MONITOR LAKE ERIE	16 MONITOR LAKE ERIE	17 MONITOR LAKE ERIE	18 ARR WINDSOR 1130 HRS	19 WINDSOR	20 WINDSOR
	21 WINDSOR	22 DEPART WINDSOR 0800 HRS	23 MONITOR LAKE HURON	24 MONITOR LAKE HURON	25 MONITOR LAKE HURON	26 MONITOR LAKE HURON	27 MONITOR LAKE HURON
	28 MONITOR LAKE HURON	29 MONITOR LAKE HURON	30 MONITOR LAKE HURON	1 MONITOR LAKE HURON	2 ARR CCIW 0100 DEP CCIW 1700	3 MONITOR LAKE ONTARIO	4 MONITOR LAKE ONTARIO
	5 MONITOR LAKE ONTARIO	6 MONITOR LAKE ONTARIO	7 MONITOR LAKE ONTARIO	8 ARR CCIW 1240 HRS	9 CCIW	10 CCIW	11 CCIW
OCT	12 CCIW	13 CCIW	14 DEPART CCIW 1000 HRS	15 TEMP MONITOR LAKE ERIE	16 TEMP MONITOR LAKE ERIE	17 TEMP MONITOR LAKE ERIE	18 TEMP MONITOR LAKE ERIE
	19 TEMP MONITOR LAKE ERIE	20 TEMP MONITOR LAKE ERIE	21 ARRIVE CCIW 0100	22 DEPART CCIW 1020 HRS	23 SEDIMENT SAMPLING	24 LAKE ONTARIO	25 SEDIMENT SAMPLING
	26 SEDIMENT SAMPLING	27 LAKE ONTARIO	28 SEDIMENT SAMPLING	29 LAKE ONTARIO	30 ARRIVE CCIW 1200 HRS	31 DEPART CCIW 1235 HRS	1 MONITOR LAKE ONTARIO
	2 MONITOR LAKE ONTARIO	3 MONITOR LAKE ONTARIO	4 MONITOR LAKE ONTARIO	5 ARRIVE CCIW 0945 HRS	6 CCIW	7 CCIW	8 CCIW
	9 CCIW	10 CCIW	11 CCIW	12 DEPART CCIW 1000 HRS	13 TEMPERATURE SURVEY	14 LAKE SUPERIOR	15 TEMPERATURE SURVEY
NOV	16 LAKE SUPERIOR	17 TEMPERATURE SURVEY	18 LAKE SUPERIOR	19 TEMPERATURE SURVEY	20 LAKE SUPERIOR	21 TEMPERATURE SURVEY	22 LAKE SUPERIOR
	23 TEMPERATURE SURVEY	24 LAKE SUPERIOR	25 TEMPERATURE SURVEY	26 LAKE SUPERIOR	27 ARRIVE CCIW 1845 HRS	28 CCIW	29 CCIW
	30 CCIW	1 DEPART CCIW 1205 HRS	2 MONITOR LAKE ONTARIO	3 MONITOR LAKE ONTARIO	4 MONITOR LAKE ONTARIO	5 MONITOR LAKE ONTARIO	6 ARRIVE CCIW 1120 HRS
DEC	7	8	9	10	11	12	13

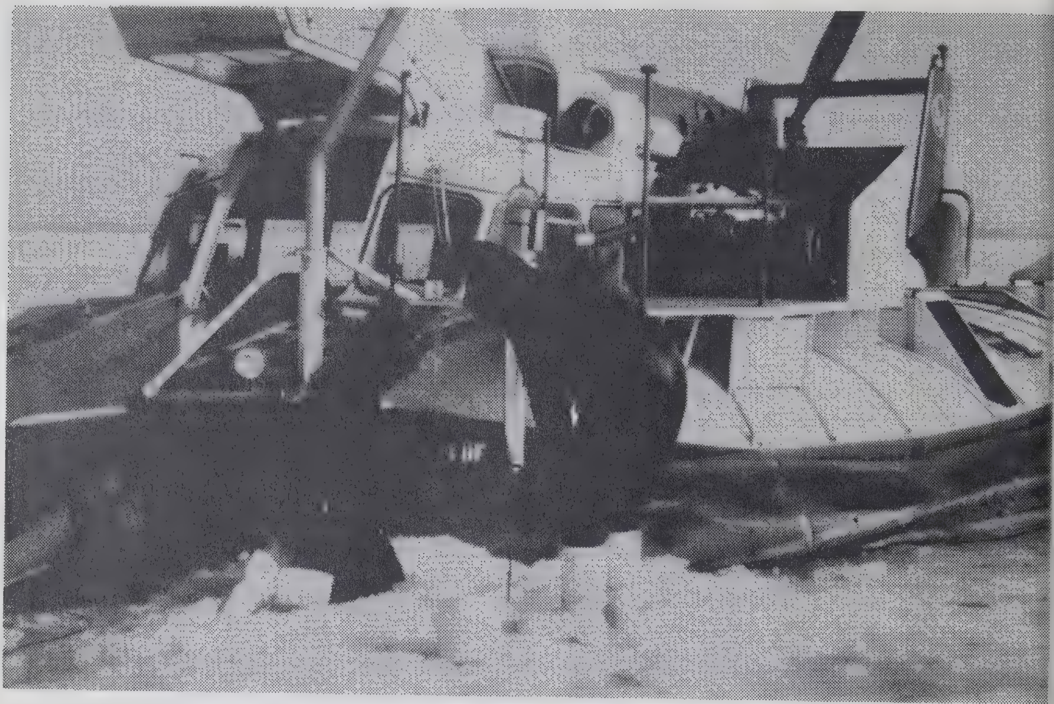


Figure 9. Sampling on Lake Erie from SK-5 Hovercraft, February 1969.

Scientific Towers – Technical Operations Section coordinated the erection of four scientific towers for measurement of water conditions and related meteorological factors in lake locations at Oshawa, Hamilton Beach, Grimsby (Jordan Harbour) and Lake 239, Kenora.

Administration Section

During 1969, the administrative support staff provided services such as budgeting, financial control, auditing, accounting and procurement of equipment, instruments, and material and supplies requirements for all sections of the Great Lakes Division. In addition, the Section was responsible for duplicating, typing service and accommodation for all components involved in the research program located in temporary quarters on site.

The Section has also been actively involved in procuring furniture and equipment, and planning of accommodation and facilities for the new buildings, now under construction.

Coordinator's Office for International Field Year for the Great Lakes (IFYGL)

Beginning in February 1969, CCIW provided staff and facilities for an office for the coordination of the Canadian scientific programs in the International Field Year for the Great Lakes. This program is part of the International Hydrologic Decade and the coordinator has close contact with the office of the Canadian secretariat of the Canadian National Committee for the IHD, in Ottawa.

IFYGL is a joint United States–Canadian study which has been planned for several years, to provide a better understanding of basic physical processes in the lakes for improvement of Great Lakes water resource management. It is to take maximum advantage of capabilities of both Unites States and Canadian research groups in a fully coordinated intensive attack on Lake Ontario physical problems.

The ongoing activities of both Canadian and United States agencies and researchers will gain through this coordinated program.

The opportunity is also being taken to use Lake Ontario as a model ocean to undertake investigations of air-water interactions needed to improve long-range weather forecasting techniques. The intensive data collection phase, scheduled to start on January 1, 1972, will last for 12 months. A number of provincial, federal

d university agencies are contributing to the ogram.

The general program guidance for IFYGL is e responsibility of an eight-man steering mmittee, with four representatives from each untry. Scientific program recommendations the steering committee are provided by national working groups chaired by Dr. G.T. anady, University of Waterloo, Dr. G.K. odgers, Great Lakes Institute, University of ronto, Mr. J.A.W. McCulloch, Meteoro-gical Branch, Department of Transport, and r. D.F. Witherspoon, Engineering Division, land Waters Branch, Department of Energy, ines and Resources. The program will consist "core" projects in lake meteorology, water ovement, energy budget and water budget. ecial research projects can be carried out by orkers from many countries to take advantage the core program data.

The Canada Centre for Inland Waters has dorsed the proposed core program and has mmitted part of its ship, launch, tower, buoy d current-meter resources to the program. ne Department of Transport has committed e *Porte Dauphine* to the Great Lakes Insti-te, University of Toronto which in turn has mmitted this to the Field Year. Meteoro-gical Branch, Department of Transport has reed to undertake the Canadian part of the eteorological aspects of the core program.

The IFYGL program addresses itself to the ysical aspects of the basin. The biological and emical community will take the opportunity intensify their work in Lake Ontario in 972. CCIW ship cruises are being planned to ovide accommodation and facilities to bio-gists and chemists.

Scientists from all nations have been invited participate in the Field Year. CCIW will play major role in providing facilities for such orkers.

The CCIW library, in collaboration with the oordinator, is providing a continuing abstract-ng service for the Field Year and is making the bstracts available to all interested parties.

A data centre is being established at CCIW s the Canadian Data Centre for management, issemination and custody of core data from ne program.

LIBRARY

The library collection is being developed toward the goal of CCIW eventually having a comprehensive library on water resources, with special emphasis in the Centre's fields of water pollution, lakes and hydraulics.

The collection now consists of 4,000 books and 955 serials (these include 105 data series, 75 reports-in-series, 20 major abstracting services and the remainder, periodicals). Sixteen hundred back volumes of selected periodicals have been obtained (on microfilm where possible). Twelve hundred reprints from older journals have been requested by scientific staff members and obtained for them. Translations of 16 foreign language articles were made for staff members during the year by the federal government's Translation Bureau.

Exchanges of publications have been arranged with 75 other institutions and CCIW produced a first volume of collected reprints during 1969 for exchange purposes.

A revised list of serial holdings has just been completed, the acquisitions list continues to be produced twice monthly and the staff is co-operating with Mr. MacDowall in producing an annotated IFYGL bibliography. A bibliography of staff articles is also compiled annually for distribution to interested persons who can obtain reprints of those articles of interest. The librarian acts as search editor for scientists' computer profiles; two profiles were composed during the year and further ones will be developed in 1970. Planning for a computer-produced index to our reports-in-series is under way. The library has recently taken responsibility for CCIW's collection of slides and organization of these is in progress.

The library is open to persons engaged in water research and a number of university students and other research workers used the collection during the year. An increasing number of requests for inter-library loans are being received as the library grows. Cooperation with other libraries is continually being expanded.

Plans for the new permanent library facilities are being made; some systems analysis of library procedures is planned prior to detailed specifications for the work area in the new library.

MARINE SCIENCES BRANCH DETACHMENT

The increase in field activity at the Centre was reflected in the expansion of Branch support, both in fleet strength and in personnel.

Three new craft, a 44-ft aluminum vessel, a 34-ft steel launch and a 40-ft pontoon boat, were acquired bringing the total launch complement to 10.

CSS Padel II, a 113-foot Fairmile class cutter was transferred to the Marine Sciences Branch from National Research Council and assigned to CCIW.

The ice-strengthened *MV Martin Karlsen* (ex-*KRISTA-DAN*) was chartered for a three-year period. The tug *Lac Erie* was also chartered for a similar period.

Two Decca minifix positioning systems were operated in support of field programs. The extensive survey control and calibration required for one of these chains was provided by George Wimpey & Co. Ltd. under contract.

DEPARTMENT OF NATIONAL HEALTH AND WELFARE

Public Health Engineering Division – Part of the Division bacteriological staff participated in eight Great Lakes monitor cruises during 1969; five cruises were made on Lake Ontario, two cruises on Lake Erie; and one on Lake Huron. Five of the cruises were made to obtain information on the distribution and density of "health-oriented bacteria"; i.e., coliforms, fecal coliforms, and the Proteus group. The other three cruises were made to obtain information on the distribution and density of specific autotrophic bacteria and to obtain information on bacterial biomass distribution. During the above cruises, 1,536 samples of lake water were collected and a total of 5,728 tests were performed on these samples.

The Kingston bacteriological laboratory participated in a project designed to examine the surface and colloidial properties of lake sediments in selected Lake Ontario sites. This project was carried out under the overall title of MELON I. A total of 208 tests were performed on 27 core samples shipped to our laboratory. Listed below are the parameters for which the core samples were tested:

1. Methane production, MPN;
2. Iron oxidizing bacteria, MPN;
3. Sulphur reducing bacteria, MPN;
4. Aerobic viable (MF) counts at 35° 20°C and 4°C;
5. Anaerobic viable (MF) counts at 20°
6. Determination of dehydrogenase tivity; and
7. Autotrophic ammonium – oxidizi bacteria.

A taxonomic study of the heterotroph bacteria found in Lake Ontario was initiated 1969. This is an ongoing project that is e pected to take three to four years.

POLICY AND PLANNING BRANCH DETACHMENT

This unit, under the direction of Dr. Lee, will be responsible for developing resear programs concerning water use complementa to existing natural science programs. The u will examine aspects of the social and econom role of the Great Lakes in relation to wat management problems.

Present staff of the unit, four members, a qualified in economics, sociology and geogr phy. An overall research program for the unit presently being developed and individu members will be taking part in ongoing resear programs at the Centre.

PUBLIC RELATIONS AND INFORMATIO SERVICES

Effective water management depends cooperation at all levels of the communit Public understanding of the objectives of t Centre is therefore vital to their achieveme and to the ultimate application of the Centre research findings.

From the Centre's beginning, there has bee no shortage of public interest in its activitie Journalists representing both printed and ele tronic media, civic interest groups, universi students, teachers, service clubs, school childre and others have made many hundreds enquiries concerning the Canada Centre f Inland Waters, its purpose, work and achiev ments.

The Centre's need to tell and the public need to know, resulted in the appointment

e spring of a public relations officer and the bsequent establishment of a public relations iit at the Centre.

During the year, stories and feature articles ı the Centre and its work appeared in various wspapers and magazines, and in radio and levision programs.

A major article appeared in the Hamilton pectator in June. Time magazine included a port on CCIW in a special article on pollution a July issue. An article on the Centre's tivities as related to, and assisted by small-oat owners was prepared in July for the agazine, Canadian Boating. The Burlington azette interviewed the acting director of the entre for a special article on pollution. Radio ation CFOS reported a special story on the ake Huron cruise of *Limnos* and Dofasco ublic relations staff ran a story and pictures of e Centre in its staff magazine.

The Lake Erie Time Study project was the bject of a special news conference and was idely reported in newspapers throughout the iagara Peninsula as well as in publications in e United States. The same study was also atured in a later report by a Hamilton pectator reporter who was flown to the barge r exclusive interviews with the scientists volved.

A visit to the Centre in August by the inister then responsible for water, Hon. Otto ang also provided an opportunity for inter-ews and stories which were given good overage by all the local media.

In September, television viewers throughout e Peninsula were introduced to the Centre ıd its work through a Saturday evening rogram which was doubled in length for the ccasion. Filmed over a three-day period earlier the summer, it focussed on a cruise of the *V Martin Karlsen* and the associated research ork involved.

During September, the Toronto Star, the oronto Telegram and radio station CHAM in amilton also carried stories based on inter-ews with CCIW officials.

Public speaking engagements for the public lations officer and for various other staff embers, included service clubs, professional sociations and civic interest groups.

To increase the effectiveness of public tours of the laboratories and ships, a slide show was produced, early in the year which by year's end had been shown to audiences which totalled several thousand.

Schools and universities were especially interested in the CCIW and in the last three months of 1969, requests for literature, for visits to the Centre and for speakers from the Centre resulted in young audiences alone totalling more than 970.

In October talks were begun with Hamilton school teachers with a view to developing more effective ways of communicating with students. At the close of the year, these talks had produced enthusiastic response and some original and promising ideas for further consideration.

Design of a logogram to instantly identify CCIW on signs, letterheads, vehicles, ships and buildings was completed. Moreover, as the year closed, a comprehensive public relations program had been drafted, including detailed planning for a number of new publications, audiovisual aids and other communications vehicles.

SUPPORT SERVICES

Building Program

The year 1969 saw the completion of the site development and prime site services for the permanent Canada Centre for Inland Waters. These facilities include underground water distribution, storm sewers, an underground high-voltage electrical service, gas mains, a launch basin, a breakwater, major ship berthing facilities, main roadways and electrical distribution for the buildings and outside lighting.

The design of the heating and cooling plant, the research and development building, the warehouse workshop building, and the main laboratory and administration building was completed during the year. Design of the water quality pilot plant progressed to an advanced stage and the hydraulics research building design concept was near completion.

A contract was awarded in September 1969 for the construction of the first buildings. This contract covers the heating and cooling plant, the research and development building and the

warehouse workshop building. Construction work is on schedule and the initial buildings will be occupied by the Centre's personnel during 1970.

Foundations for the main laboratory and administration building were contracted for in November 1969, and tenders for the construction of the building will close in January 1970. This building should be completed in the spring of 1972.

Construction of the water quality pilot plant is expected to commence in the spring of 1970. Completion of this plant is scheduled for early 1971.

The hydraulics laboratory will be the final building to be constructed. Present schedules call for its completion during the calendar year 1972.

WATER QUALITY DIVISION DETACHMENT

The CCIW detachment of the Water Quality Division is responsible for coordinating, planning, organizing and conducting chemical analyses of Great Lakes waters for water quality and pollution studies, and for research and development of analytical methodology for these waters.

During 1969 this Detachment was actively engaged in coordinating analytical requests and conducting the chemical monitoring of Great Lakes waters. Intensive studies were made on Lake Ontario while some analytical background data on water quality for lakes Erie, Huron and Superior were obtained. The chemical monitoring program is carried out to provide information on changes and trends in water quality of the main body of the Great Lakes and to provide base-line data to permit assessment of the impact of pollution abatement programs. Completed projects of the Detachment for the year are:

1. Chemical Monitoring — Twelve full chemistry monitor cruises; 9 on Lake Ontario, 2 on Lake Erie and 1 on Lake Huron were completed. Approximately 2,600 water samples from these cruises were analyzed for orthophosphate, silica, nitrate, ammonia, alkalinity and total phosphate. About 6,000 samples were analyzed by Technical Operations Section personnel for specific conductance, turbidity and dissolved oxygen for which the reagents, tec niques, and instruments as well as the techni supervision were provided by the Water Quali Division Detachment. About 1,100 water sa ples collected from lakes Ontario, Erie a Huron were analyzed at the shore laborator for cadmium, chromium, cobalt, copper, irc lead, manganese, molybdenum, nickel, vanadiu and zinc by atomic absorption spectrophot metry using solvent extraction techniques.

2. Water Quality Network — As part of t total sampling program, 60 designated wat quality network stations on lakes Ontario, Er Huron and Superior were visited once duri the year for assessing long-term continuo water quality trends in these lakes. Sampl from these stations were analyzed for nutrier and other major constituents.

3. Interstitial Waters — About 170 samp of interstitial waters from sediments of weste Lake Ontario were analyzed for major a minor constituents for the Great Lakes Di sion.

4. Rain Water Quality — A joint investi tion with the Chemical Limnology Section, w carried out on the quality and treatment glass wool for use as filter plugs for collecti rain water samples. Investigations indicated th even the pyrex glass wool not treated with ac and adequately washed with double distill water was a source of contamination of ra waters in which nutrients and trace metals we determined. About 15 rain water samples c lected by the Chemical Limnology Secti from five meteorological stations duri August, September and October were analyz for major ions, nutrients, and trace elemen composition.

5. Scientific Training — Nine technical p sonnel from the Technical Operations Sectio were trained for a period of one week instrument methods and techniques to det mine pH, conductance, turbidity, and dissolv oxygen. Two persons from the Chemi Limnology Section, were trained on the au mated analyses of nutrients, and were provid with methods to analyze samples connect with the MELON project. Three post-gradua students from the University of Guelph we

so trained on automated methods for determining nutrients and on the operation of tomatic analyzers. The students are working ıder a contract between their University and CIW on ecological studies in the Grand River outh—Lake Erie region. The training was ovided to ensure that uniform analytical ethods are used in the study of Great Lakes d its tributary waters.

6. Special Studies

i. A special survey of Hamilton Bay was conducted to check on the effects of hydrochloric acid on the waters of this Bay.

ii. Analyses for oil and grease were made on samples collected of Great Lakes waters by McMaster University for the contracted project to study the emissivity of the water surface under various conditions (see Physical Limnology Section of this report).

iii. Special micronutrient analyses were made for bio-assay projects of the Fisheries Research Board to study the limiting micronutrients for algae.

7. Research and Development on Methdology and Instrumentation — To determine ery small amounts of increased or decreased nnual pollution loads it is essential that continual research and development of analytical methods be made and in this regard the following studies were conducted:

i. A simultaneous, four-channel, continuous automated assembly was developed for measuring soluble nutrients onboard ships.

ii. A multiple filtration assembly was developed for quick and continuous filtration of samples for trace-element analyses.

iii. Two new instruments, an organic carbon analyzer and a submersible water-quality monitor, were evaluated and calibrated for Great Lakes studies.

iv. An automated colorimetric method for the determination of less than 5 ppm sulphate was evaluated, modified and is under investigation.

v. Automatic atomic absorption methods for manganese, molybdenum and vanadium were investigated and set up to determine these metals which are found in trace quantities in Great Lakes waters; methods are sensitive to 0.1, 0.1 and 0.2 part per billion respectively.

These methods are being described for publication.

APPENDIX A

CCIW Staff (as of December 1969)

Acting Director, CCIW – J.P. Bruce
Secretary – Miss L.F. Leiper
Executive Assistant to A/Director, CCIW – T.S. Hillis
Librarian – Mrs. E.A.C. Fosdick
Building Services Superintendent – D.F. Stewart
Support Staff, CCIW – Miss A.E. Boerchers, Mrs. C.E. Davidson, C.F. Hicks, G.M. Mowbray, Mrs. B.D. Titley, Mrs. E. Vos

Environmental Quality Coordination Unit

Head, Dr. A.R. LeFeuvre
Technical Support – H.H. Dobson
Personnel Administration, CCIW – Miss R. Kelly, Mrs. C. Shepherd, Miss M.R.J. Warren

DEPARTMENT OF FISHERIES AND FORESTRY

Fisheries Research Board Detachment

Head, Dr. R.A. Vollenweider
Support Staff – G.F. Carpenter, R.H. Collins, J.K. Leslie, J.E. Moore, H.F. Nicholson, Miss L.L. Sully
Postdoctoral Fellow – Dr. M. Munawar (jointly with Chemical Limnology Section, Great Lakes Division)
Senior Scientific Staff of Freshwater Institute, Winnipeg, working on Great Lakes Problems

Director, Dr. W.E. Johnson
Scientific Leader, Eutrophication Section, Dr. J.R. Vallentyne
Dr. A.L. Hamilton
Dr. K. Patalas
Dr. J. Stockner

DEPARTMENT OF NATIONAL HEALTH AND WELFARE

Public Health Engineering Division

Liaison Officers – Dr. C.P. Fisher, Ottawa; B.J. Dutka, Kingston
Support Staff – P. Collins, A. Jurkovic, A. Menon, H. van Otterloo

DEPARTMENT OF ENERGY, MINES AND RESOURCES

Great Lakes Division, Inland Waters Branch

Chief, J.P. Bruce

Chemical Limnology Section

Scientific Staff	Research Fields
Head, Dr. Mary E. Thompson	specific-ion electrodes; low temperature aqueous geochemistry
Dr. N.M. Burns	physical chemistry of water; carbon cycle in lakes
Dr. Y.K. Chau	trace elements in the lake environment
Dr. A. Lerman	geochemistry of brines; radioisotopes in lake sediments
Dr. R.F. Platford	physical chemistry of aqueous solutes
Dr. R.R. Weiler	surface chemistry of sediments
Postdoctoral Fellow – Dr. C.W. Childs	physical chemistry of aqueous solutes

Chemists

M.E. Fox	soluble organic compounds in large lakes
H. Saitoh	trace elements
M.T. Shiomi	atmospheric precipitation chemistry; nutrient cycles in large lakes

Technical Staff – R.D. Coker, R.W. Kuntz

Computer and Data Services Section

Acting Head, D.M. Francis
Programmers – Miss P. Lloyd Jones, H.C. Pulley
Support Staff – W. Nagel, Mrs. P.A. Moody, Mrs. K.M. Schopf, Mrs. M. Kinder

Engineering Systems Section

Head, G.A. Jones
Electronics Unit Head – A.E. Eatock
Electronics Engineers – K.N. Birch, K.R. Peal
Mechanical Unit Head – A.E. Pashley
Mechanical Engineer – P.M. Ward-Whate
Technologists – J.A. Diaz, D.P. Fekyt, M. Pedrosa, J.G.M. Laroque, H.A. Savile, R. Boucher, J.D. Heidt
Drafting Office – W. Finn, Miss S. Longstaffe

Physical Limnology Section

Scientific Staff	Research Fields
Head, Dr. R.K. Lane	remote sensing, heat exchange
Dr. H.S. Weiler	circulation, air-lake interaction
Dr. C.R. Murthy	diffusion, circulation
F.C. Elder	air-lake interaction; thermal effluents
F.M. Boyce	internal waves, heat content, oil slicks
P.F. Hamblin (educational leave)	circulation, seiches
D.G. Robertson	descriptive limnology, climatology
H.W. MacPhail	electronics

Technical Staff – D.C. Beesley, R.G. Chapil, F. Chiocchio, R.K. Dolling, K.C. Miners, W.J. Moody, W.D. McColl H.K. Nicholson, Mrs. V. Jackson

Limnogeology Section

Scientific Staff	Research Fields
Head, Dr. P.G. Sly	distribution and variance of lake bottom sediments
Dr. C.F.M. Lewis (GSC)	post-glacial uplift and stratigraphic correlation of recent sediments
Dr. A.L.W. Kemp	distribution and diagenesis of organic compounds in recent sediments
Dr. N.A. Rukavina	interpretation of sediment distributions in nearshore zone
Dr. R.L. Thomas	distribution, occurrence and authogenesis of minerals, major elements and trace metals in recent sediments
J.P. Coakley	distribution, occurrence and relation to erosion, transportation and deposition of active sediments
C. Gray	diagenesis of recent organic compounds
W. Warwick	palaeoecological interpretation of chironomids

Technical Staff – W. Booth, G. Duncan, Mrs. M. Hicks, Mrs. M. Istvanov, Mrs. L. Mansey, Mrs. A. Mudrochova, R. Sandilands

Technical Operations Section

Head – H.B. Macdonald
Special Assignments – D.J. Cooper
Senior Operations Officer, *CSS Limnos* – A. Holler
Senior Operations Officer, *MV Martin Karlsen* – H.W. MacPhail (transferred to Physical Limnology, Oct. 1969
Senior Operations Officer – D. Hanington (relieving duties, *CSS Limnos* and *MV Martin Karlsen*)
Technical Staff – K. Barnes, L. Benner, H. Cho, H. Gschwind, P. Healey, M. Mawhinney, B. Moore
H. Ng, L. Piniuta, P. Seidenberg, F. de Vree, S. Withers, P. Youakim

Administration Section

Head – H. Lawson
Support Staff – J.L. Harris, Mrs. S.M. Horne, D.G. Jefferson, A.W. Mayes, Miss I. O'Connor

International Field Year for Great Lakes

Canadian Coordinator – J. MacDowall

Marine Sciences Branch Detachment

Head – A. Quirk
Support Staff – Capt. T. Mangan, J.E. Parsons, Miss L.A. Thomson, K.D. Robertson, J. Allan, H.E. Greencor
F.M. Morrison, J.G. Delorey, D.G. Ashdown, N.L. Keeping, N.L. Goulden, G.A. Boutillier, J.H. Maccab
G. Sproule (23 ships crews – seasonal)

Policy and Planning Branch Detachment

Miss M.R. Sinclair
J.N. Thomson
Miss N.M. Wakulin

Public Relations and Information Services

A.R. Kirby

Water Quality Division Detachment, Inland Waters Branch

Head – Dr. V.K. Chawla
Technical and Scientific Support – H. Alkema, W.D. Blythe, O. El Kei, S. Meszaros, F. Philbert, Y.M. Sheikh

APPENDIX B

Committees and Associations

nerican Meteorological Society, Committee on Water Resources – Dr. R.K. Lane

nerican Water Resources Association, Board of Directors – J.P. Bruce

nadian Aeronautics and Space Institute, Founder member of the Hydronautics Section – J. MacDowall

mmittee on Water Resource Applications, Program Planning Office for Interdepartmental Committee on Resources Satellites and Airborne Remote Sensing, Chairman – Dr. R.K. Lane

strumentation Advisory Committee, Mohawk College – G.A. Jones

terdepartmental Committee on Submersibles – Dr. P.G. Sly

terdepartmental Working Group on Contingency Plans, Chairman – J.P. Bruce; Members – F.M. Boyce, Dr. A.R. LeFeuvre

ternational Association for Great Lakes Research (IAGLR), Vice-president – J.P. Bruce; Editorial Board, Proceedings of 13th IAGLR Conference – Dr. R.K. Lane, Dr. P.G. Sly; Exhibits Committee, 13th IAGLR Conference, Canadian Chairman – G.A. Jones

ternational Field Year for the Great Lakes, Canadian Coordinator – J. MacDowall;
Energy Budget – Dr. R.K. Lane, F. Boyce;
Lake Meteorology Working Group – F.C. Elder;
Steering Committee – J.P. Bruce;
Terrestrial Water Balance – Dr. R.K. Lane;
Water Movement Working Group – Dr. H.S. Weiler.

4th International Geological Congress – 1972, Montreal – Excursion Planning – Dr. P.G. Sly, Dr. C.F.M. Lewis

ational Research Council Associate Committee on Avionics – J. MacDowall

ational Research Council Subcommittee on Hydrology – Dr. R.K. Lane

orth American Working Group on Manganese – Dr. R.L. Thomas

olid Earth Science, Marine Geology Committee of the Science Secretariat – Dr. P.G. Sly

APPENDIX C

Publications and Presentations

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No. 4, 1966, Lake Ontario, Cruise 66-5, June 26-30, (Oct. 1969).
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APPENDIX D

National Advisory Committee on Water Resources Research
Advisory Committee on the CCIW

MEMBERSHIP LIST – January 29, 1970

A.T. Prince, Convener	Director, Inland Waters Branch, Dept. of Energy, Mines and Resources, Ottawa, Ont.
E.G. Pleva, Chairman	Department of Geography, Middlesex College, University of Western Ontario, London, Ont.
cretariat	
. H.F. Fletcher	Executive Secretary, National Advisory Committee on Water Resources Research, Policy and Planning Branch, Dept. of Energy, Mines and Resources, Ottawa, Ont.
S. Hillis	Executive Assistant to the Acting Director, Canada Centre for Inland Waters, Dept. of Energy, Mines and Resources, P.O. Box 5050, Burlington, Ont.
iembers	
r. P.M. Bird	Director, Environmental Health Centre, Dept. of National Health and Welfare, Tunney's Pasture, Ottawa, Ont.
)r. C.P. Fisher, Alternate	Associate Chief Research, Public Health Engineering Division, Dept. of National Health and Welfare, Tunney's Pasture, Ottawa, Ont.
.P. Bruce	Acting Director, Canada Centre for Inland Waters, Dept. of Energy, Mines and Resources, P.O. Box 5050, Burlington, Ont.
J.W. MacLaren	James F. MacLaren Ltd., Consultant Engineers, 321 Bloor St. E., Toronto, Ont.
Dr. A.D. Misener	Director, Great Lakes Institute, University of Toronto, Toronto, Ont.

Prof. W.K. Oldham	Department of Civil Engineering, University of British Columbia, Vancouver 8, B.C.
Dr. G. Prevost	5626 Woodbury Avenue, Montreal, Que.
T.L. Richards	Superintendent of Hydrometeorology, Meteorological Branch, Department of Transport, 315 Bloor St. W., Toronto, Ont.
Dr. G. Shane	Director, Research, Shell Oil Canada Limited, Box 400, Terminal A, Toronto 1, Ont.
Dr. D.R. Stanley	Stanley and Associates Engineers Limited, 11810 Kingsway, Edmonton, Alta.
F.A. Voege	Assistant General Manager, Ontario Water Resources Commission, 135 St. Clair Ave. W., Toronto, Ont.
T.E. Weber	Director, Water Control and Conservation Branch, Dept. of Mines and Natural Resources, 693 Taylor Ave., Winnipeg 9, Man.

Observers

J.B. Bryce	Hydraulic Engineer, The Hydro Electric Power Commission of Ontario, 620 University Ave., Toronto, Ont.
Dr. N.E. Cooke	Principal Chemical Engineer, Canadian Industries Limited, 630 Dorchester W., Montreal, Que.
Prof. J.H. Dales	Department of Political Economy, University of Toronto, Toronto, Ont.
Prof. K.S. Davar	Dept. of Civil Engineering, University of New Brunswick, Fredericton, N.B.
R.K. Fraser	President, Fleet Manufacturing Ltd., Box 300, Fort Erie, Ont.
J.P. Gourdeau	Vice-President, Surveyor, Nenniger and Chenevert Inc., 1550 O. Boul. de Maisonneuve, Montreal, Que.

B. Hooper	City Engineer, City of Peterborough, City Hall, Peterborough, Ont.
r. W.E. Johnson	Director, Freshwater Institute, Fisheries Research Board of Canada, 501 University Cresc., Winnipeg 19, Man.
rof. J.R. Kramer	Department of Geology, McMaster University, Hamilton, Ont.
rof. A. Leclerc	Head, Division of Sanitary Engineering and Hydrology, Ecole Polytechnique, 2500, Ave. Marie Guyard, Montreal 250, Que.
Prof. H. Lees	Head, Department of Microbiology, University of Manitoba, Winnipeg 19, Man.
Roy A. Walker, Alternate	Assistant Hydraulic Engineer (Studies)
Dr. A. DesMarais	Principal Science Adviser, Science Secretariat, Privy Council Office, East Block, Parliament Buildings, Ottawa, Ont.
H.C. Kingstone	Deputy Head, U.S.A. Division, Department of External Affairs, Ottawa, Ont.
J.L. MacCallum	Assistant to the Chairman and Legal Adviser, International Joint Commission, 151 Slater St., Ottawa 4, Ont.
M.S. Slivitzky	Université du Québec, 220 Est Grande-Allée, Quebec 4, Que.
Dr. E.Y. Spencer	Director, Research Institute, Canada Department of Agriculture, London, Ont.
H.G.P. Taylor	Director, Resource Programs Division, Department of Finance, Confederation Building, Ottawa, Ont.

APPENDIX E

Contracts Entered Into by the Great Lakes Division – 1969

The contracts let by the Great Lakes Division are for specific research projects designed to supplement the total research program of GLD.

Contracts are entered into when resources are not available at the Centre for allocation to projects which provide an important supplement to the ongoing program. The following contract programs were initiated in 1969:

1. Analysis of the long-term effects of the disposal of waste heat from electric power production and industrial plants into the waters of the Great Lakes Basin, including an assessment of the quantity of waste heat to be absorbed and the pattern of its disposal.
(H.G. Acres & Co. – $36,000)

2. To provide an evaluation of research related to ice on rivers and lakes, including the Laurentian–Great Lakes System, according to the following, surface freezing, growth and dissipation of an ice cover and its effects, ice in water, ice floods, ice forces, shipping problems, trafficability, environmental effects, instrumentation, physical properties, control methods and treatment systems.
(H.G. Acres & Co. – $35,000 – in collaboration with other Divisions of Inland Waters Branch)

3. To provide limnological data for lakes Ontario, Erie, Huron and Superior and Georgian Bay.
(Great Lakes Institute, Univ. of Toronto – $25,500)

4. To provide limnological data for the eastern end of Lake Ontario from monitor cruises and from a special cruise to support infrared scanner flights. To provide a report on the movement and thermal turbidity characteristics of the thermal bar as it occurs this spring in the western end of Lake Ontario in the MELON project area.
(Great Lakes Institute, Univ. of Toronto – $35,000)

5. To carry out an investigation at the coastal jet phenomenon in an area to the west of Lake Ontario, of Oshawa.
(Waterloo University – $22,750)

6. To develop programs for the processing of data obtained from CCIW Chemical and Bacteriologica Monitor Cruises on the Great Lakes.
(McMaster University – $26,650)

7. To carry out a research project on the geological studies of the nearshore zone of Lake Superior from Sault Ste. Marie to Wawa in accordance with the Lake Superior, Sedimentological Reconnaissance Program.
(Lakehead University – $14,000)

8. To study seasonal thermal changes in the susceptibility of alewives and correlation of heat resistance to factors of lake temperature and characteristics of fish, which will be done in laboratory experiments, using fish from Lake Ontario since alewife die-off is a form of pollution which seriously impairs recreational and water supply uses of Lake Ontario.

To undertake a preliminary study of the role of temperature as a directive factor in movement and distribution of alewives in the Lake.

To prepare a bibliography on alewives.

To undertake a feasibility study on possible investigation of alewife response to temperature gradient rather than warm or cold temperature.
(Waterloo Lutheran – $13,000 – in collaboration with Fisheries Research Board)

9. To carry out a program of short-term measurements of incoming solar radiation, solar radiation reflected from the lake surface, diffuse solar radiation, net total radiation, and total incoming radiation, commencing during May and continuing through October 1969 at a location in Lake Ontario.
(McMaster – $16,000)

10. To install tower(s) at sites – A, B, and C in Lake Ontario in order to carry out combined research programs in the areas of (1) air-water processes (2) radiation studies and (3) diffusion studies.
(Young and Forbes Diving and Marine Spec. – $10,000)

11. To supply a team of two divers for a period of April 21 to September 19, 1969.
(John T. Roe Underwater Salvage & Recovery – $12,000)

12. To conduct a study: i) to assess the estuarial waters where the Grand River enters Lake Erie with respect to (a) physical-chemical changes in river water, disposition of suspended solids, accumulation of insecticide residues and other pollutants, (b) productivity with respect to bottom fauna, plankton, and nekton including energy transfer; ii) to determine the significance of the discharge of the Grand River with respect to its influence on the water quality and eutrophication of Lake Erie.
(University of Guelph – $13,800)

CANADA CENTRE FOR INLAND WATERS

1970

CANADA CENTRE FOR INLAND WATERS – 1970

Frontispiece. CCIW permanent buildings from the West. Far left, Water Quality Pilot Plant; centre, Workshop – Warehouse – R & D Building; right, Heating and Power Plant; seven-storey main laboratory building under construction behind R & D Building.

CANADA

Canada Centre for Inland Waters - 1970

During 1970, the Canada Centre for Inland Waters was responsible to the Department of Energy, Mines and Resources (Minister, the Honourable J.J. Greene). By the date of publication, responsibility for the Centre had been transferred to the Honourable Jack Davis, Minister of Fisheries and Forestry, and Minister Designate of the proposed Department of the Environment.

CANADA CENTRE FOR INLAND WATERS
DEPARTMENT OF FISHERIES AND FORESTRY
BURLINGTON, ONTARIO, MARCH 1971

Contents

ERRATA

pp. 7 and 8 Figure 2 (a) and Figure 2 (b)

A. Surface Temperature °C.

B. Surface Chlorophyll *a* mg/m^3.

C. Surface Primary Production mgC$_{ass}$/m^3/hr.

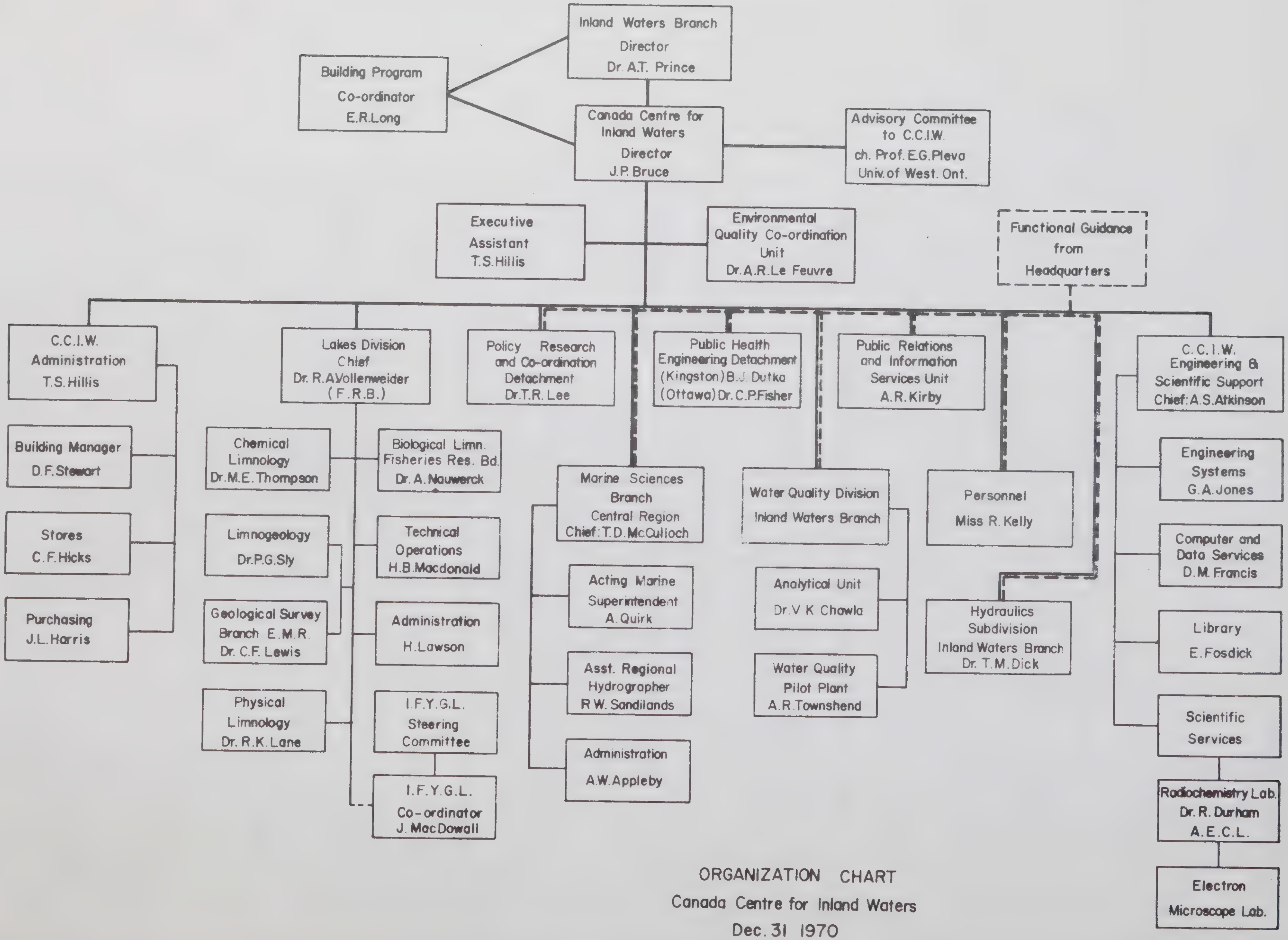
D. 0 - 50 m Net Plankton loss on Ignition mg/m^3.

p. 12 *hot-film anemombers* should read *hot-film anemometers.*

p. 14 Figure 8 should read figure 9.

p. 15 Figure 9 should read figure 8.

p. 40 *specification electrodes* should read *specific ion* electrodes.



ORGANIZATION CHART
Canada Centre for Inland Waters
Dec. 31 1970

Highlights 1970

The year 1970, the third full year in the life of the Canada Centre for Inland Waters, was an extremely eventful one. The activities and achievements of the Centre in 1970 are described in this report, and the more significant of these events listed in this opening section.

Completion of First Permanent Buildings

On November 20, the Minister of Energy, Mines and Resources dedicated the Centre's first permanent buildings (Figure 1). The buildings, which include the workshop, warehouse, research and development building and the heating plant, were completed close to schedule at a cost less than 1% above the $4 million construction budget.

The Water Quality Pilot Plant, designed to test the performance of new waste-treatment methods on a pilot plant scale, was closed in by the end of the year and should be in operation by June 1971. The reinforced-concrete frame of the seven-storey main laboratory building was completed to the fifth-floor level at year's end; the building should be ready for occupancy early in 1972. Plans for the Hydraulics Laboratory Building were completed and construction is scheduled to begin in April 1971.

Staff Appointments and Organization

A number of important staff changes took place in 1970. J.P. Bruce, Chief of the Great Lakes Division and Acting Director of the Centre, was appointed Director of the Canada Centre for Inland Waters on May 12. Great Lakes Division was renamed Lakes Division to reflect the countrywide scope of its activities and the post of Chief of the Division was taken over by Dr. R.A. Vollenweider, on secondment from the Freshwater Institute of the Fisheries Research Board. Dr. Vollenweider was formerly Head of the Fisheries Research Board detachment at the Centre. With this appointment, the FRB staff work on biological limnology became a responsibility of the Lakes Division and Dr. A. Nauwerck was appointed Acting Head of the FRB unit.

In early October, A.S. Atkinson, formerly of Atlantic Oceanographic Lab., Bedford, N.S., assumed responsibility for the Engineering & Scientific Support Division which includes Engineering Systems Section, Computer & Data Services, Common User Scientific Laboratories and the Library. Through an agreement with Atomic Energy of Canada Limited, Dr. R. Durham of the AECL staff was appointed to CCIW with responsibility for development and management of the new radiochemistry laboratory.

Transfer of Central Region, Marine Sciences Branch

During the summer, the staff of the Central Region of Marine Sciences Branch, numbering about 100 members, was transferred from Ottawa to the Centre. The Central Region has two major responsibilities. One is to undertake hydrographic charting of navigable waters from the mouth of the St. Lawrence River to the Saskatchewan-Alberta border. The second is to maintain and operate the fleet of vessels and launches used for the hydrographic surveys and for the scientific programs of the CCIW.

NTA Evaluations

CCIW played a major part in conducting and co-ordinating a joint Canada-U.S.A.-Sweden evaluation of the potential environmental impact of NTA, the substance most likely to replace phosphates in detergents. Dr. Y.K. Chau's work at the Centre demonstrated the capability of NTA to return trace metals to the waters. The trace metals involved include copper, zinc and mercury, deposited in the sediments of polluted areas such as Hamilton Harbour. Dr. A. Lerman and Dr. C.W. Childs developed mathematical models to predict the concentrations of NTA and various NTA metal complexes in the water environment.

At year's end, these and other results were combined with U.S. public health preliminary findings concerning the tendency of NTA, at high concentrations, to increase the deleterious effects of the metals cadmium and mercury in producing birth defects in rodents. The latter findings suggest the need for caution in the use of NTA pending further investigations. As an outcome of the three-nation experience with NTA evaluations, plans were laid for development of a general program of tests to which all potential pollutants entering the environment in significant quantity should be subjected.

Mercury Pollution

A survey program to determine the extent of mercury contamination of the sediments and waters of the Great Lakes was developed. This program is designed to complement surveys of the mercury content of fish, conducted by the Freshwater Institute of the Fisheries Research Board and by Ontario Government agencies. Maps showing mercury distribution in the sediments of Lake Ontario and Lake St. Clair were completed before the end of the year and similar maps of Lake Huron and Lake Erie are in course of preparation. The Lake Ontario map showed disturbingly high concentrations off the mouth of the Niagara River. By dating the layers of a core from Lake

Figure 1. Dedication ceremony for new buildings at CCIW. Left to right: Hon. George Kerr, Minister of Energy and Resources Management, Ontario; Dr. J.R. Weir, Chairman, Fisheries Research Board of Canada; Mayor George Harrington, Town of Burlington; Mr. R.E. Tait, Chief, Public Health Engineering Division, Dept. of National Health and Welfare, Canada; Hon. J.J. Greene, Minister of Energy, Mines and Resources, Canada; and Mr. J.P. Bruce, Director, Canada Centre for Inland Waters.

Ontario, it was possible to compare the level of mercury in industrially-contaminated sediments with the natural background levels of mercury which existed prior to 1900.

Dr. R.L. Thomas, who supervised this work, was consulted frequently by provincial and federal agencies on a number of associated problems, including the possibility of dredging mercury-laden sediments. Dr. Y.K. Chau published details of a very sensitive chemical analytical method for determining mercury in water and supervised a program for analyses of lake and rain waters.

Toxic Substances

To anticipate likely problems of a serious nature concerning environmental toxic substances, biologists, chemists and others at the Centre prepared a list of 18 potential pollutants. As a first step, economic geographers in the Resources Research Unit are undertaking surveys of industrial and other uses of these substances to help direct environmental monitoring programs to areas where problems are most likely to occur. Surveys of the substances most likely to cause problems – PCB's, cadmium, zinc, and lead – are underway in Great Lakes waters, sediments and biota.

Contingency Plans

Two staff members of the Centre (F.M. Boyce and A.R. LeFeuvre) provided technical assistance to the Ministry of Transport in the early stages of the ARROW oil spill disaster in Chedabucto Bay, Nova Scotia, in February.

A federal interdepartmental contingency plan for oil spills was approved, under the terms of which CCIW is responsible for co-ordinating federal operations on the Great Lakes. The technical Field Manual for clean-up of spills of oil and toxic materials, prepared by an interdepartmental working group chaired by Dr. LeFeuvre, was in press at year's end.

Project Hypolimnion

A major field program co-ordinated by Dr. N.M. Burns and directed towards obtaining more complete information on the causes, effects and extent of oxygen depletion in the bottom waters of Lake Erie, was carried out in the central basin in collaboration with the U.S. Federal Water Quality Administration.

The study showed that the tremendous algal blooms which occurred used up all the available phosphorus in the surface waters, and on sinking to the bottom and decaying rendered an area of more than 1000 square miles of bottom waters completely devoid of oxygen. It was found also that significant regeneration of phosphates from the decaying algae and from sediments occurred in the anoxic area, but that this was not the case if measurable dissolved oxygen concentrations were present.

U.S.–Canada Great Lakes Pollution Abatement

The International Joint Commission held six public hearings early in 1970 to receive submissions and hear argument based on the 1969 Report of the Advisory Boards on Pollution of the Lower Great Lakes. CCIW staff members attended the hearings and in several cases presented evidence. The IJC issued an interim report in the spring supporting a number of the recommendations of the Advisory Boards.

In June, a meeting of Canadian cabinet ministers and their U.S. counterparts established a joint working group and a number of sub-groups to work out detailed Canada-U.S.A. agreements. CCIW is represented on the sub-groups on water quality criteria and abatement programs (R.A. Vollenweider), contingency plans (A.R. LeFeuvre), research co-ordination (J.P. Bruce – Co-Chairman), and special situation communications (T.R. Lee). Much of the work of these sub-groups was completed by the end of the year. Another meeting of ministers is expected to take place in 1971.

Advisory Committee to Canada Centre

Dr. E.G. Pleva, University of Western Ontario, was re-elected chairman of the Advisory Committee to the Canada Centre. The Committee reviewed CCIW programs and provided advice on program development. Working groups on water research grants and contracts to the private sector (Chairman, J.F. MacLaren), university participation and occupation of space at CCIW (Chairman, Dr. Pleva), and water quality pilot plant (Chairman, A.R. Townshend) were active during the year. In November, ACCC established a working group to advise on development of hydraulics programs.

Appendix D lists the members of the Advisory Committee and the Working Groups.

Department of the Environment

In late 1970, the Government announced its intention to establish a Department of the Environment based in part on the Department of Fisheries and Forestry, and incorporating the Water Sector of the Department of Energy, Mines and Resources, the Meteorological Service of the Ministry of Transport, portions of the Environmental Health Centre of the Department of National Health and Welfare, and several other units. On the basis of the discussions which have been held regarding the organization of the Department of the Environment, it is clear that all components of the Canada Centre for Inland Waters will form part of the new department. There is no doubt that a Centre administered entirely by a single department will offer a greater degree of efficiency in the use of administrative and support services and a higher level of co-ordination in program planning than could be expected from the multi-departmental form of organization with which CCIW started 1970.

Lakes Division (Inland Waters Branch)

CHEMICAL LIMNOLOGY SECTION

Activities during 1970 were dominated by two large and equally urgent projects – the necessity to understand better the possible consequences to the environment of possible widespread use of NTA (nitrilotriacetate) in laundry detergents, and the need to acquire quantitative information on the accelerating deterioration of the quality of Lake Erie waters, especially during late summer when a large area of the bottom water is devoid of oxygen. Both projects required a much increased number of contacts and exchange of information with scientists at other water research centres, in Canada, U.S.A., and Sweden.

Other projects conducted in the Section include a program to monitor rain chemistry on the Canadian side of the Great Lakes; a study of the physical chemistry of aqueous chloride-sulphate solutions, and combination of these data with published analyses of natural brines to construct models of the natural evolution of such brines; construction of geochemical models of rates of formation of steady-states in lakes, of rates of transport of chemical species across the sediment-water interface, and of the distribution of nuclear-fallout in the Great Lakes, and planning a chemical program for Lake Okanagan.

An organic chemist, Dr. W.M.J. Strachan, joined the Section in August, and a post-doctoral research fellow, Dr. J.O. Nriagu, came in September. Dr. Nriagu is an economic geochemist and is concerned with chemical equilibria in lake sediments.

Chemical Monitor Cruises

The Chemical Limnology Section is responsible for the planning and the evaluation of the results of the chemical monitor cruises on the Great Lakes. The samples are collected by personnel of the Technical Operations Section, Lakes Division, and analyzed by staff of the Water Quality Division. Several concurrent research projects of other units at the CCIW make use of the cruises or the data from the cruises. The contract arranged in 1969 with Prof. J.R. Kramer of McMaster University to develop computer programs to facilitate retrieval and analysis of the cruise data, was continued during 1970, and now all of the STAR cruise data for Lake Ontario and Lake Erie from 1966 to present are "cleaned-up" and available for retrieval, sorting, and statistical testing by a variety of computer programs.

A full year of monitor data was accumulated for Lake Ontario for monthly cruises starting in April 1969 and ending in March 1970.

Lake Erie was monitored intensively during 1970, with nine cruises during the period April to December. Ice on Lake Erie prevents cruises during January, February and March.

Two special programs were conducted during 1970 to amplify the information obtained by routine cruises. The first, in May, was a study of the chemical effects of the thermal bar in western Lake Ontario – see Project In Situ, below. The second was a special study of conditions in the Central Basin of Lake Erie during August – see Project Hypolimnion, below.

Project In Situ

This project was undertaken to study the effects on the chemistry of the lake water of the "thermal bar", a phenomenon which persists for a month or so in Lake Ontario during the spring warming period, and which may be defined as the region where the thermocline of the warmer inshore water becomes vertical and meets the colder, isothermal, off-shore water. Stations on either side of the "bar" were monitored for several short time series – 24 to 36 hours, for a number of chemical parameters, including nutrients, some major ions, and trace metals. Preliminary evaluation of the data shows a statistically significant separation by the "bar" of two chemically distinct bodies of water, especially with respect to nutrients.

Project Hypolimnion

In December of 1969 a joint project by the Canada Centre for Inland Waters and the U.S. Federal Water Quality Administration, Lake Erie Basin Office, Cleveland Ohio was conceived to study the extent and mechanisms of oxygen depletion in the central basin of Lake Erie. Much comment and criticism from the staff of CCIW and the Freshwater Institute, Winnipeg, was received and the final plan was formulated in close conjunction with FWQA scientists in March 1970. Dr. N.M. Burns of Chemical Limnology Section acted as project co-ordinator and organizer for the input from CCIW. Mr. Curtis Ros organized the input from the FWQA.

It was decided that current meters, winds recorders an thermographs from the FWQA were to be used to monitc water movements in the basin. The C.S.S. Limnos would b used to survey 24 chemical parameters at 25 stations an

temperature profiles at 41 stations across the basin every 4 days. Bacterial and biological processes were to be investigated at 5 major stations using the launch C.S.L. AGILE. The project was finally carried out much as it was planned with some parts of the program being even more successful than was hoped for.

In all 7 basin surveys were carried out. A number of the scientists were scuba divers who observed and photographed a very interesting sequence of changes on the sediment surface. Also, divers carrying short pieces of plastic core liner (about 1 ft. long) were able to take sediment-water interface samples for bacterial and other analyses. The co-operation between the scientists from the two countries was very effective and free of any difficulties.

The pattern of oxygen depletion was clearly observed with anoxic conditions first appearing in the western end of the basin and then progressing eastward as the summer continued. By the end of August 1970 1000 sq. miles of the basin was anoxic with the oxygen depletion causing large-scale nutrient regeneration.

The mechanisms of oxygen depletion are still to be extracted from the data together with analyses of other nutrient, biological and bacterial interactions.

NTA Studies

Early in the year it became apparent that NTA (nitrilotriacetate) might be introduced in the environment in large quantities if it were used widely as a substitute for polyphosphates in laundry detergents, yet very little was known about the possible effects of NTA in lake waters. It was clear that the first requirement was for a reliable analytical method. The Microtek gas chromatograph, which was intended to be used in the separation and identification of soluble organic compounds from lake water, was used instead to detect the propyl ester of NTA, after development of a pre-concentration step by anion exchange resin. The method, which can also be used to determine EDTA in lake water, is lengthy and is only used for analyses where high accuracy and sensitivity are required.

In other early experiments, not NTA but its effects were studied. It was decided to test the extent to which a reaction like

$$Pb_3(PO_4)_2 + 3NTA^{\equiv} \rightarrow 3PbNTA^- + 2PO_4^{\equiv}$$

would go to the right, which could be studied by permitting NTA to react with solid metal phosphates and then monitoring the solution levels of metal and orthophosphate. Tube studies in Hamilton Harbour indicated that there was positive release of metals from the sediments by NTA, but the phosphate levels varied without an obvious relationship to the NTA. Orthophosphate is an extremely labile and biologically active substance in the ecosystem, and a lack of correlation is not unexpected.

Laboratory studies on NTA-sediment interactions also indicated release of metals, particularly zinc and iron.

A computer program, available in the literature, was used to calculate the chemical forms of nitrilotriacetate in solutions approximating lake water in composition. In particular, the distribution with respect to various heavy metals, to more abundant species such as Ca, Mg and Na, and to competing ligands, was evaluated. The results showed that at lower concentrations of NTA (<0.4 mg/1), $cuNTA^-$ would be the principal NTA species present.

Rain Chemistry Project 1970

The sampling network of the Rain Chemistry Project (see Annual Report 1969) was expanded in 1970 and now comprises a total of 15 stations in the Canadian Great Lakes region. There are now 8 stations in the Lake Ontario basin, 3 stations in the Lake Erie basin, 2 stations in the Lake Huron basin and 2 stations in the Lake Superior basin. The final sampling site was installed in July 1970. All 15 sampling sites are equipped with the bulk precipitation type of sampler.

Another type of precipitation sampler has been installed at the site of the Canada Centre for Inland Waters research complex. This sampler collects only rainfall, opening automatically at the start of rain and closing on the cessation of rain. The automatic action of this sampler can be reversed so that it acts as a dry-fallout or dust collector. It is hoped that the information obtained from this apparatus will augment that from the bulk precipitation (rainfall plus dry fallout) samplers and help us to better understand the chemical nature of precipitation.

Physical Chemistry of Aqueous Solutions

We are continuing an experimental program designed to collect activity coefficients of multicomponent salt solutions which resemble natural brines.

We are now making, or have made, measurements on the following systems over the temperature range from 0° – 25°;

$H_2O - NaCl - Na_2SO_4$
$H_2O - NaCl - K_2SO_4$
$H_2O - KCl - Na_2SO_4$
$H_2O - KCl - K_2SO_4$
$H_2O - Na_2SO_4 - K_2SO_4$

The only major change in our study of mixed salt solutions is that emphasis is now being placed on measurements in the temperature range down to the freezing point of aqueous solutions. Some measurements at 25° are still being completed but we probably have enough information now to estimate solubilities in mixed salt solutions at this temperature, and it is more important to determine how activities and solubilities vary with temperature.

We are also making preliminary measurements to assess the isopiestic method described by Kirkintsev (Russ. J. Inorg., Chem *13*, 600 (1968)) of measuring solubilities in mixed salt solutions.

Geochemical Models

Work on geochemical models centered around two classes of processes:

(i) How fast chemical steady-states may be attained in stratified and unstratified lakes, and in the oceans, after the existing chemical and physical conditions in the environment have been changed;

(ii) Transport of dissolved matter across sediment-water interface.

The study of (i) showed that chemical steady-states in lakes should be re-established within, at the most, a few years to tens of years, depending on the water residence time in the lake and the rates of chemical reactions. For a relatively rapidly degrading species (half lives measured in days or months) the final steady-state concentrations in lakes of intermediate and large size would be very low compared with the concentration in inflow.

In (ii) a study has been done of migration of dissolved species out of the sediment, due to continuous dissolution of detrital minerals in two of the Kenora lakes. The chemical flux out of the sediment amounts to as much as 15-30 percent of the total dissolved solids budget of the lakes. The rates of dissolution of minerals within the sediment are of the order of magnitude comparable to the rates of sedimentation, the latter presumably compensating for the partial dissolution.

In Lake Ontario, migration of sodium and chloride from the lake water into the sediment has been explained as a diffusional process. The total amounts of sodium and chloride accumulated in the sediment during the last 60-50 years are very small compared to the total amount of salt which has passed through the lake. The conclusion is, therefore, that the sediment has only a negligibly small effect on the removal of sodium and chloride from lake water.

A mathematical model has been developed for computing the Strontium-90 (half-life 29 years) concentration in the five Great Lakes simultaneously. The computed concentrations for the period 1954-1960 are in a reasonably good agreement with the analytical data on Sr-90 in the Great Lakes. Migration of the nuclear fallout products Sr-90 and Cesium-137, into the sediments of Lake Superior and Lake Ontario is primarily a diffusional process: the two radionuclides diffuse from the lake into the interstitial water and they are being taken up by the sediment particles. The uptake of Sr-90 and Cs-137 by the lake sediments has a very small effect on the concentrations in lake water. This picture is in principal similar to the small effect of the sodium and chloride diffusion into the sediment.

Geochemistry of Brines

Work on the chloride-rich brines has been completed with good results. At the present state of the art it is possible to predict a stage in the process of brine concentration at which sodium chloride begins to precipitate. The general thermodynamic model applies to a wide variety of brines in which the main and dominant anion is chloride. Realizing the importance of chloride-sulphate type brines in the Prairies, work has been started on the chemical behaviour and evolution of chloride-sulphate waters in nature. The necessary thermodynamic data on aqueous solutions and chemical analyses of natural brines are being collected and considered for the purpose of arriving at a predictive model which should describe the course of evolution and precipitation of minerals in chloride-sulphate brines.

Okanagan Studies

A chemical program for the five Okanagan lakes (Okanagan, Skaha, Osoyoos, Kalamalka, Woods) has been prepared. The program is aimed at obtaining a variety of chemical data during the 1971 sampling operations season. The field and laboratory chemical data will be used in the evaluation of chemical budgets of the lakes and elucidation of some of the more important chemical processes, the understanding of which is required in the longer range planning of the water quality and resources utilization.

BIOLOGICAL (FISHERIES RESEARCH BOARD)

The FRB Detachment represents the biological section of the Lakes Division of CCIW. Its main objectives are three: (1) to monitor and analyze spatial and temporal distribution of organisms in the Great Lakes; (2) to conduct laboratory and field experiments on the relationship between organisms and different environmental factors, especially the factors which are related to eutrophication and water pollution; (3) to develop methods for monitoring

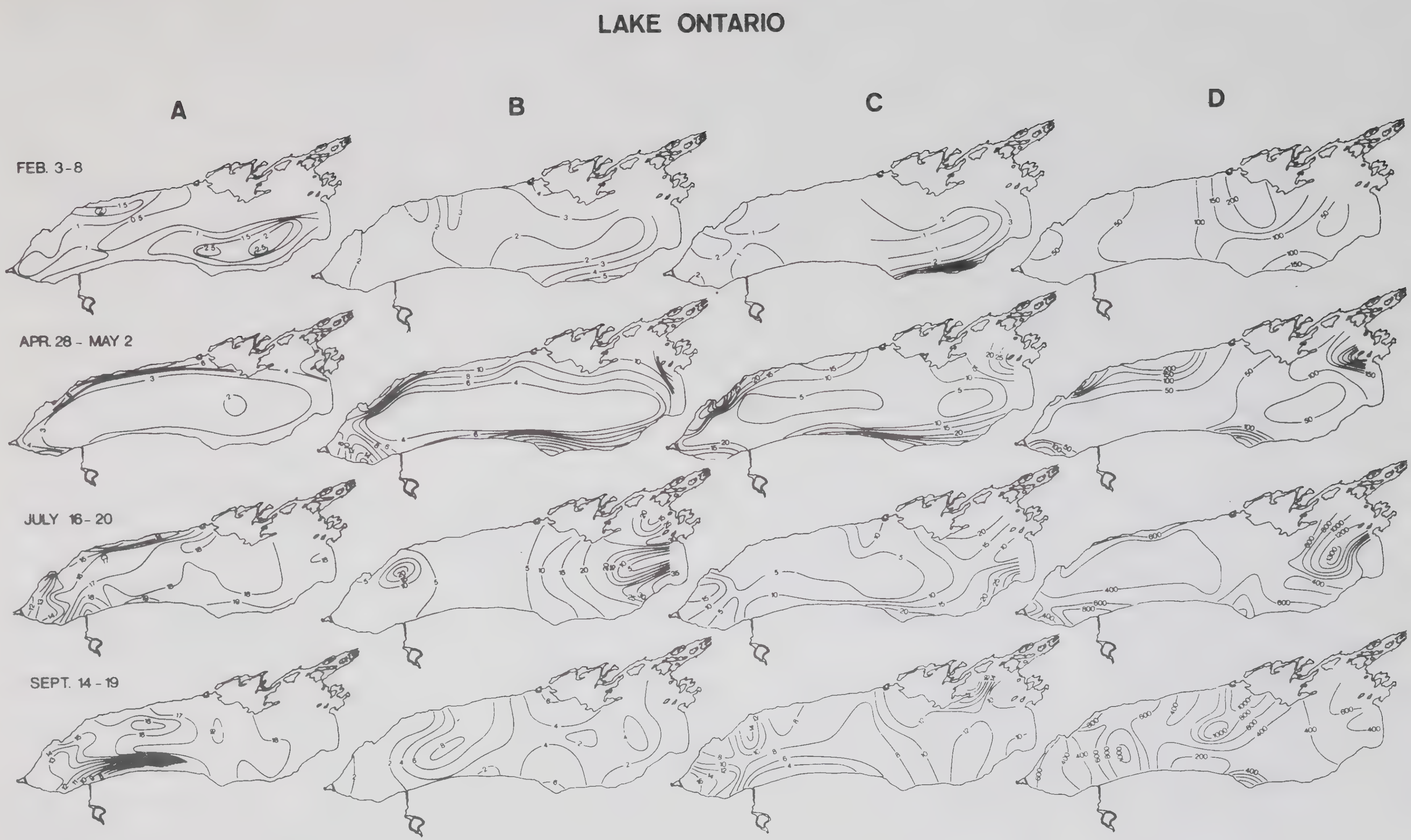


Figure 2(a).

LAKE ERIE

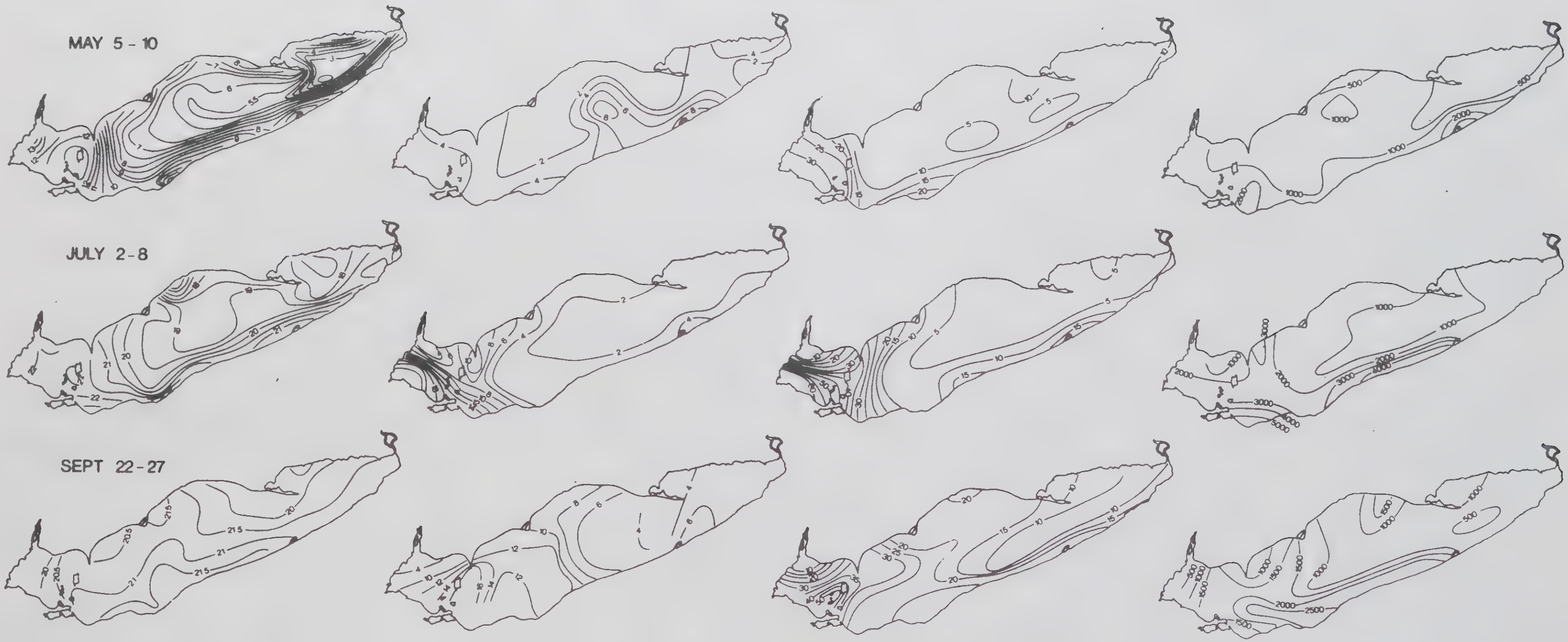


Figure 2(b).

biological features which are not yet accessible to automatic analysis.

Monitor Cruises

In 1970, FRB participated in 13 monitoring cruises on Lake Ontario (January to December), 10 cruises on Lake Erie (April to December), and 2 summer cruises to Lake Huron, Lake Superior and Georgian Bay. From a total of approximately 70 stations, 686 samples were taken for phytoplankton enumeration, 910 samples for zooplankton enumeration, 701 samples for determination of total biomass, 646 samples for determination of plant pigments, and 615 samples for estimation of primary production. Further, 565 bioassays were performed on shipboard to study stimulation and inhibition by nutrients and trace metals. In addition, chlorophyll was determined by continuous *in situ* fluorometer measurements for all cruises.

Figure 2 shows the development of some parameters as measured by the monitoring program in Lake Ontario and Lake Erie, 1970.

In Lake Ontario, chlorophyll starts to build up in shallow inshore areas in spring. Later, it spreads offshore into the lake, and its highest concentrations appear in the eastern parts of the lake in late summer. A similar picture has emerged for Lake Erie, but here the maximum usually remains in the shallow western basin of the lake.

Primary production is closely related to chlorophyll content, but characteristic differences exist between Lake Ontario and Lake Erie. While chlorophyll concentrations are similar in the two lakes (summer average 5 - 6 mg $C1_a/m^3$, summer maximum about 40 mg $C1_a/m^3$), primary production is about two times higher in Lake Erie (Ontario 10.5 mg C_{ass}/m^3h, Erie 21 mg $C_{ass}/m^3/h$).

The loss on ignition in the net samples (dry weight minus ash weight) roughly expresses the total biomass of zooplankton. In both lakes, its distribution is characterized by a strong patchiness but also by a striking constancy of the general distribution pattern. A time-lagged relationship between primary production and zooplankton biomass, and a strong correlation between temperature and zooplankton growth can be observed. Zooplankton biomass reaches 2 - 3 times higher values in Lake Erie than in Lake Ontario.

Taxonomy

The species list of phytoplankton, zooplankton and bottom fauna of the lakes is being continuously updated. The main effort in 1970 was put into the identification of plankton of Lake Ontario. Altogether, 350 species of phytoplankton were found in this lake. Only 70 of these were recorded earlier. Several species, mainly rotifers, were added to the zooplankton species list.

Plankton Distribution

Phytoplankton and zooplankton horizontal distributions were studied by means of microscopic examination of the samples. Distribution maps were prepared for all important species on Lake Ontario. Zooplankton distribution in Lake Huron and Lake Superior has been studied by Dr. K. Patalas, Freshwater Institute, Winnipeg. A preliminary report on zooplankton in Lake Ontario, Lake Erie and Lake Huron has been prepared by him.

Bottom Fauna

A project was started on bottom fauna distribution in the strongly polluted Hamilton Harbour. The aim of this study is to detect interrelationships between degree of pollution and community structure. Samples are taken from different types of sediment at all times of the year, and the bottom fauna are analyzed qualitatively and quantitatively and compared with the physical and chemical properties of the mud. At the same time, haemoglobin properties of selected groups of animals are being studied for comparison with different oxygen tensions.

Pigment Studies

Besides the routine determinations of chlorophyll *a*, on the monitoring cruises, pigment measurement techniques were evaluated and improved. Work was also done to separate and identify chlorophyll degradation products, and the temporal and spatial distribution of chlorophylls *a, b, c,* and their degradation products phaeophytin and phaeophorbide were mapped. The relationship between chlorophyll and the degradation products was shown to be an excellent key to understanding water mass history and movements.

Enrichment Studies — Bioassays

The aim of this project was to study the effects of nutrient enrichment and other chemical substances on photosynthesis and growth of natural phytoplankton associations, P, N, C, Fe, Si, K, Mo, Co and Mn were used, separately or in combinations, in a series of experiments with different concentrations, both on shipboard and in the laboratory. The effect of NTA was tested in the same way, but no significant result was found. Carbon was never found to be limiting alone, but could, in some cases, stimulate photosynthesis when given together with phosphorus (Figure 3). Of the other substances, manganese showed the strongest positive effects, but responses were not consistent, being at times positive, negative or negligible under seemingly identical conditions. These results reflect the complexity of the chemical micro-environment. The

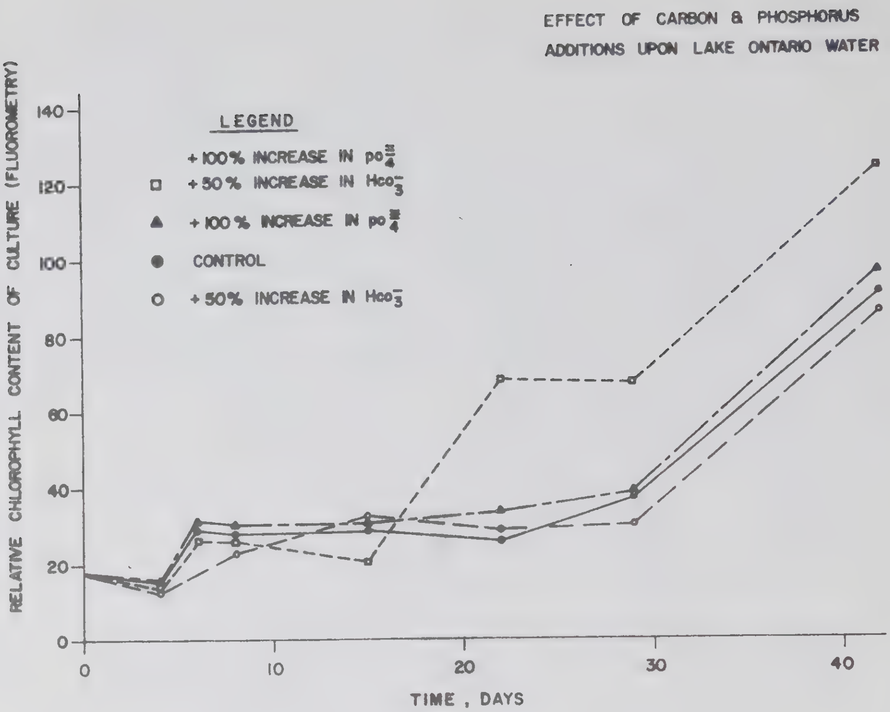


Figure 3. Effect of carbon and phosphorous additions upon Lake Ontario. waters.

importance of the accidental composition of species and their physiological state at the moment of sampling do not allow a simple interpretation of the results, and require a more sophisticated approach.

Effects of Toxic Substances on Algae

Physiology of freshwater organisms is affected by many substances entering the lake by pollution from industry and urban sewage. Pesticides and heavy metal compounds have been demonstrated to have deleterious effects on many organisms even in very small amounts.

Experiments were started to study the inhibitory effects of DDT, dieldrin and other chlorinated hydrocarbons, organic mercurial, and polychlorinated biphenyls on the growth and metabolism of algae. The C14-technique, cell counts and pigment analyses were used in the study. Preliminary results show inhibition of phytoplankton productivity at a concentration of 1 ppb of DDT and dieldrin (Figure 4).

Diurnal Variations of Biological Parameters

Sampling on monitor cruises is restricted to surface or epilimnetic waters and time of sampling has not usually been considered. Short time changes in biomass and biomass composition caused by water mass movements, migration of organisms, cycles of metabolic processes related to day/night rhythms, etc., may, however, have considerable significance.

To study these factors, 48-hour studies with continuou registrations and short-interval sampling in time and dept were done at offshore and inshore stations from a anchored ship in Lake Ontario. Considerable daily fluctu ations were found in pigment composition and primar production which indicate a strong necessity for a careft interpretation of occasional experiments as well as c observations from single points on monitoring cruises.

Long Term Studies

To study and establish the long term changes of wat quality and organism composition in the Great Lakes, da from recent studies have been collected and compared wi previous studies. Oxygen is one important element in lake's metabolism and a determining factor for its troph state. Figure 5 shows how oxygen depletion in the botto water of Lake Erie has changed since 1929.

PHYSICAL LIMNOLOGY SECTION

The Physical Limnology Section specializes in matt concerning the physics of lakes and their natural enviro ments. In 1970, a substantial portion of the scienti program included a continuation of basic physical measu ments in the Great Lakes, combined with preparations r the 1972 International Field Year for the Great La s

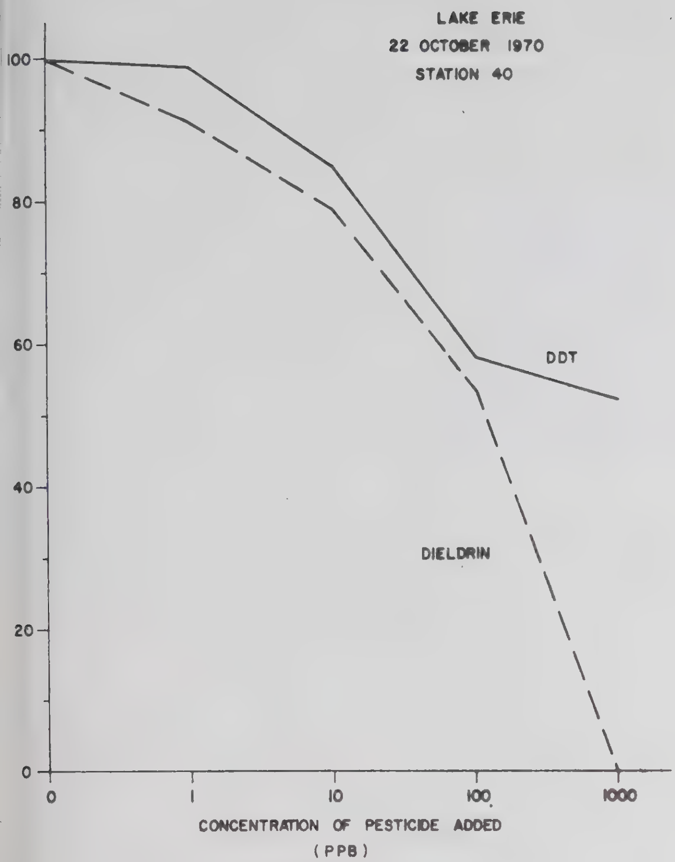


Figure 4.

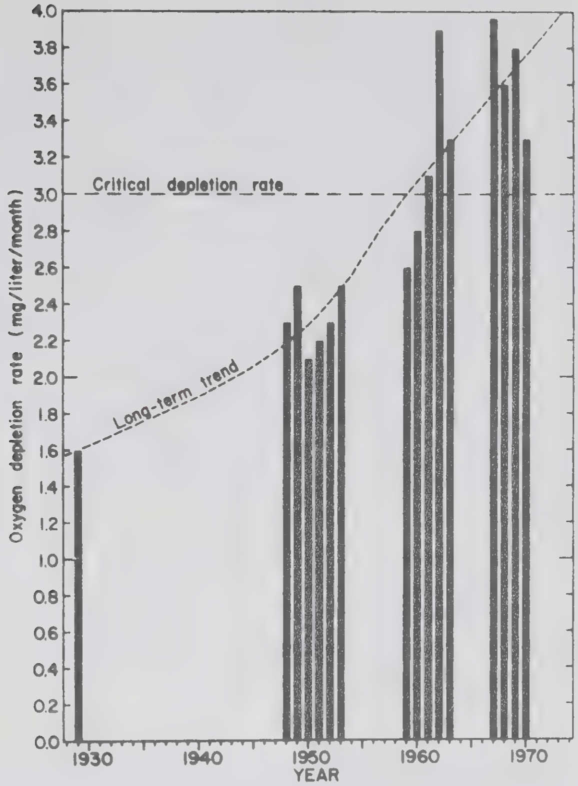


Figure 5. Mean depletion rates for dissolved oxygen during summer in the bottom water of central Lake Erie. Note that the critical rate of 3.0 mg/liter/month, reached in 1961, produces zero oxygen levels before the end of summer stratification

(IFYGL). Participation in a joint federal-British Columbia study of the Okanagan Basin was initiated and preparations were being made for the transfer of staff to the Freshwater Institute (Winnipeg) to undertake "small lakes" studies. New staff arrived late in the year to consolidate the remote sensing studies and initiate oil spill studies.

Outfall Simulation Experiment in Lake Ontario

Rhodamine B dye was released continuously in Lake Ontario, near Oshawa, 2 km offshore in 20 m deep water, 3 metres from the lake bottom from a 10 m long horizontal diffuser. The resulting plume was surveyed for 6 days at different depths and at different distances from the dye source. The measured horizontal concentration distributions were many-peaked, mostly very much wider than comparable dye plumes near the surface, and on some occasions consisted only of discrete patches of dye, hundreds of metres apart. These features of "diffusion" may be attributed to the wave-like character of flow at low residual velocity.

Coastal Current Climatology

Experimental data on coastal currents were collected during May-October, 1970 in Lake Ontario, near Oshawa, using Lagrangian and Eulerian techniques. Lagrangian velocities were measured using current-following devices (drogues) and Eulerian currents from moored and deck read-out current meters. This data will provide the basis to establish a climatology of coastal currents (near Oshawa) particularly relevant for planning locations of any sewage or cooling water outlets. Plans are underway to extend this study systematically to other coastal areas of Lake Ontario during the 1971 field season.

Small-Scale Air-Lake Interaction Studies

Studies of small scale air-lake interactions were carried out at a site offshore from Burlington. A guyed, bottom-mounted tower and a second experimental self-supporting tower were used to mount instrumentation in a water depth of 15 metres. The towers were also used in a co-operative program, by the Micrometeorological Research group, Meteorological Service of Canada.

Instrumentation for measurements of the eddy flux of

momentum, heat and water vapour were tested as a development effort for the IFYGL. These instruments included the Thornthwaite "Unit Parcel" momentum fluxmeter, two-dimensional hot-film anemombers, Lyman-alpha Humidrometer and Resistance wire thermometer. Measurement techniques were developed where sensor and transponder units were mounted on the tower and data were transmitted by cable to the recording equipment housed aboard a boat anchored nearby.

Data were successfully recorded on several days and have been only partially analyzed. The "Unit Parcel" momentum fluxmeter malfunctioned but has since been modified and is undergoing further tests. Data from the fast response sensors are not yet analyzed. Data reduction and processing techniques are being developed which will apply to the IFYGL programs.

Evaluation of the CCIW Meteorological Buoy System

The meteorological buoy system, based on the Plessey Hymet magnetic tape recorder, previously developed at CCIW, was subjected to a comprehensive field evaluation to determine accuracy and reliability under realistic operational conditions.

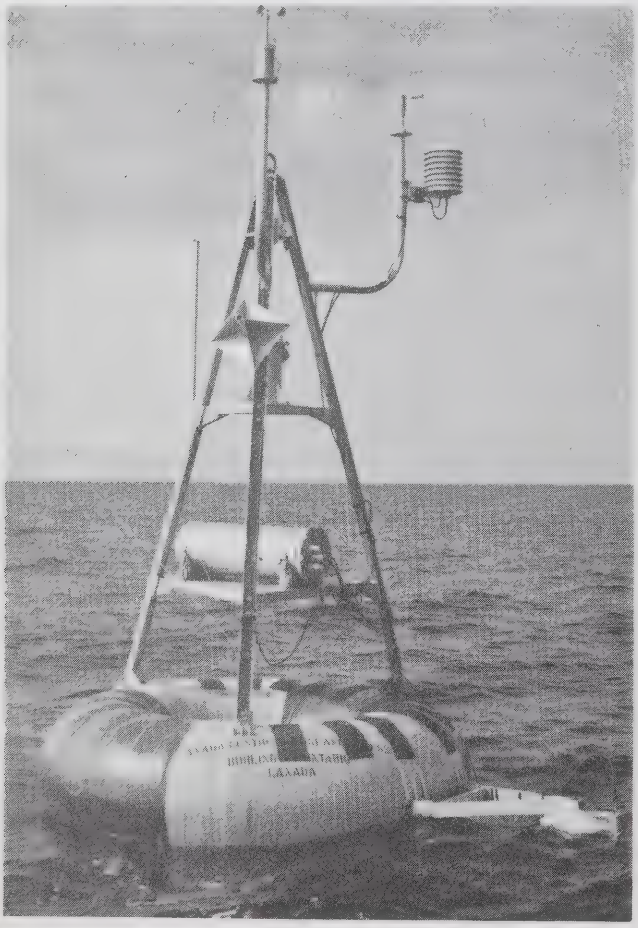


Figure 6.

The system was first evaluated for basic sensor and system accuracy through an intercomparison test with standard instrumentation at the Meteorological Research Station of Meteorological Service of Canada.

A second series of tests were conducted during July and October with the system deployed on buoys in Lake Ontario (Figure 6). During the later period, similar measurements were conducted on a Bedford Stable Tower provided near the buoy location by the Department of Transport. These measurements provide a set of data from which influences of buoy motion on system accuracy are being evaluated.

Preliminary analysis of the data from the comparison program has been completed. Results indicate that acceptable accuracies were obtained in the land-based tests. The marine environment has caused some equipment failures. The total degree of degradation of data accuracy for buoy-mounted systems is not yet determined.

In order to evaluate the feasibility of including buoy-mounted solarimeters in the IFYGL core network, two periods of intercomparisons of buoy-mounted solarimeters with tower-mounted instruments were conducted. The first, during July, suffered from a lack of rough conditions. The data from the gimbal-mounted buoy solarimeter was consistently high, with daily totals by from less than 3% up to 9%. The second period, during early October, enjoyed a wider variety of conditions but experienced greater instrumentation difficulties.

Thermal Characteristics — Instrumentation and Measurements

The towed thermistor array which was tested briefly in 1969 was completed and fully tested in 1970. This device measures water temperatures at 13 points along faired cable and records them as functions of time. The cable may be towed at speeds up to 6 knots. The 1970 program yielded data sufficient to assess the performance of the equipment and to indicate improvements needed to develop the experimental version into an operational system.

Another temperature profiling system, developed at the Atlantic Oceanographic Laboratory, Bedford Institute, Halifax, was tested along with the CCIW array. This system, known as the Batfish, consists of a towed body carrying a temperature and depth sensor which can be controlled from the ship and made to undulate between pre-selected depths. This system is potentially useful for Great Lakes research.

Generally speaking, the towed array is suited to detailed surveys where the scales of horizontal variation are less than 500 m. Examples of the phenomena which fit this category

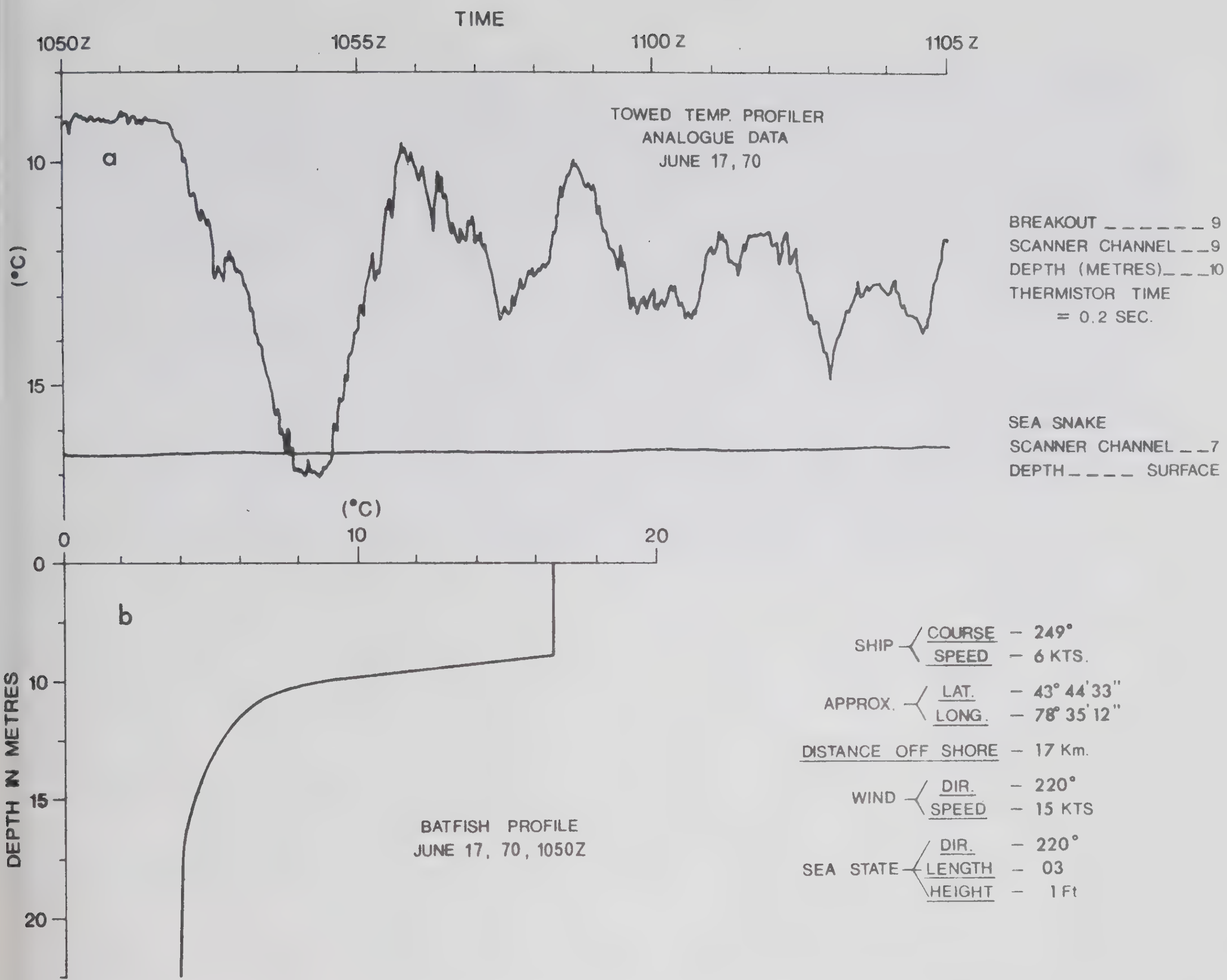


Figure 7. Example of a train of internal waves encountered off Oshawa in July 1970. (a) shows uncorrected analogue records of the surface and 10m temperature. (b) shows the temperature profile as measured by the Batfish at 1050Z. The vertical movement sufficient to cause the large increase in the 10m temperature is about 2.5m and the wavelength of the disturbance (neglecting Doppler shifts) is about 550m.

are short period internal waves (Figure 7) and turbulence, thermal plumes (heated effluents or river discharges), and the spring "thermal bar". The undulating system has a typical wave length of 1 km and therefore is suited to large scale phenomena and to lake-wide surveys. The system can be towed at 10 knots or more and the data recording requirements are less severe than for the multi-channel array. The Batfish and the array can be used together on the same ship. The combination is very powerful and yields data that may offer insights as to how large and small scale phenomena are linked.

The 1970 instrument testing program was designed also as a scientific experiment and produced data which reveal a great complexity of thermal structure. Preliminary analysis suggests that the shore regions of a stratified lake may be zones of considerable vertical mixing under appropriate conditions despite the stability afforded by the stratification.

Thermal Bar Study — Lake Ontario

Two vessels, the SURGE and the RADEL, were equipped with towed thermistors for the purpose of tracking the surface manifestations of the thermal bar off Oshawa. The principle objective of the study was to ascertain the integrity of the thermal bar over distances of several kilometres. The surface data obtained were supple-

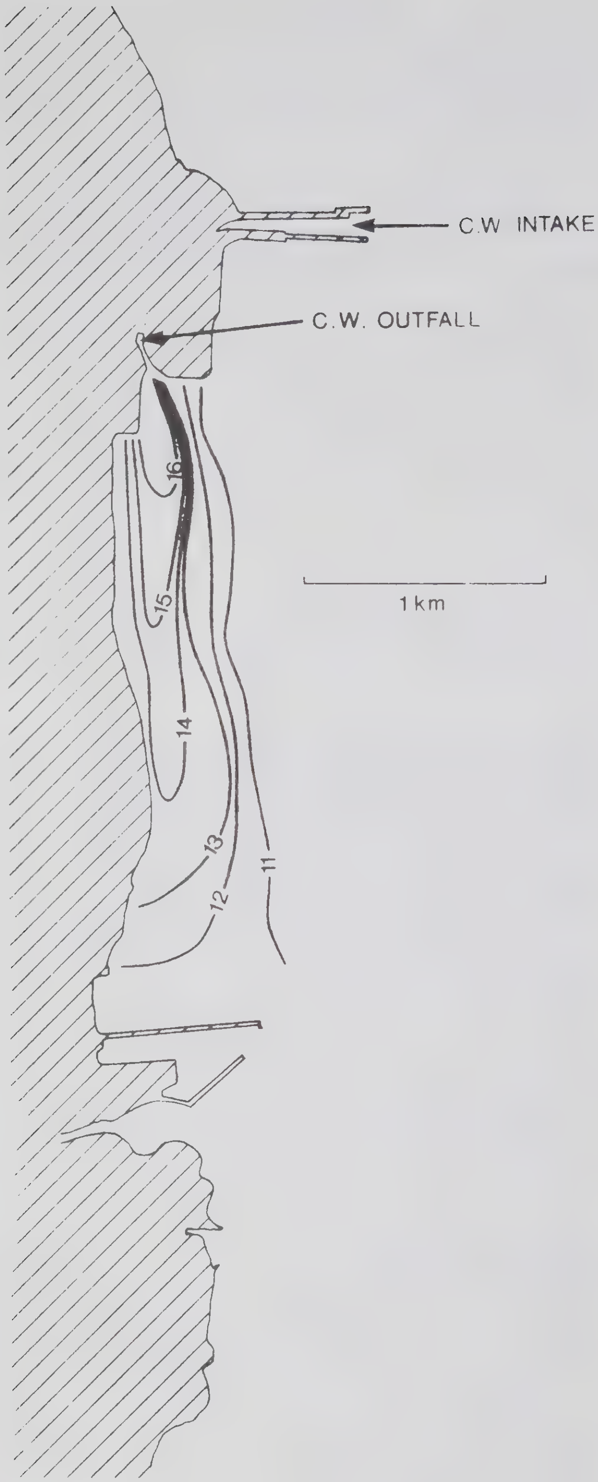


Figure 8. Surface isotherms measured by scanning infrared thermometry. Cooling water effluent (°C). Lakeview thermal generating station, 2200 megawatt capacity. Nov. 9, 1970. Altitude ~ 2000 m.

mented on two occasions by infrared images of the stud area obtained by aircraft. A major result of this study wa discovery of relatively large zones of cool water where th thermal gradients were weak. These zones (Figure 8) wer interpreted as areas of mixing whereby the warm wate adjacent to shore was mixed offshore. This study verifie that single passes with a ship perpendicular to shore woul not necessarily be representative of the thermal condition in late spring for the area off Oshawa. This is because th position and strength of the maximum thermal gradien parallel to shore could change substantially within one c two kilometres.

Thermal Effluents

A program is underway to assess the physical effects c the thermal effluent load to the Great Lakes as projecte for year 2000 in a study for CCIW by the H.G. Acres C An airborne system embodying a scanning infrared radi meter has been developed to facilitate periodic surveys c water surface temperature in the vicinity of several existir thermal effluents (Figure 9). These surveys, which began September, will continue on a weekly basis into 1971. strong correlation exists in initial data between the loc alongshore component of the wind and thermal plum advection as indicated by surface isotherms. Data c thermal plumes collected by Ontario Hydro has bee provided to CCIW for use in this study.

Project "HYPO" – Lake Erie (Diffusion, Currents ar Temperatures)

A dye patch diffusion experiment was carried out early August to study large scale diffusion characteristics hypolimnetic waters in central Lake Erie (see Chemic Limnology Section report). Experimental data were c tained by fluometric sampling, to define the peak conce tration, horizontal and vertical spread of the patch w restricted to the hypolimnion because of the stro thermocline. The horizontal spread was an order f magnitude less, corresponding eddy diffusivity two ord of magnitude less, and the observed peak concentration w two orders of magnitude greater compared to surface lay diffusion ($10^5 cm^2 sec^{-1}$) for comparable time scales of t order of 60 hours.

The currents and temperature data were obtai through co-operation with the U.S. Federal Water Qual Administration in Cleveland who furnished and moo wind recorders, current meters, and thermographs in central basin of Lake Erie. CCIW is handling the compu processing of the data. While it is known that the volume hypolimnion water decreases as the stratification procee the exact mechanisms by which the decrease takes place not clearly understood. The deployment of the moo instruments was designed specifically to study the mec-

LAKE ONTARIO – OSHAWA AREA

RS 70-102-1 May 14.,1970
Events 2-7 1400 1600 e.d.t.
Grid lines 1-7 Altitude 3000 ft.

Figure 9.

nisms of (1) entrainment of hypolimnion water through the thermocline and (2) mixing of hypolimnion water and epilimnion water around the periphery of the central basin. The 1970 field season was used to deploy the instrumentation and process the data. Analysis will continue into 1971.

Development of Numerical Models

A two part program has been initiated to simulate the water motion in Lake Ontario by numerical models. The first project aims at a systematic investigation and scrutiny of numerical techniques employed in geophysical fluid dynamics and the development of a hierarchy of models describing the circulation of the lake under various conditions. The second project is an extensive verification program to evaluate the accuracy of various models by means of the abundance of observational data on Lake Ontario to become available during 1972 (IFYGL).

The present investigation is concerned with models of the winter circulation of Lake Ontario where the lake is represented by an incompressible homogeneous fluid layer. The primitive system of equations, integrated in the vertical, is used to predict the surface elevation along with the horizontal flow pattern resulting from an imposed wind stress. Included are the effects of the earth's rotation, nonlinear acceleration terms in the equations of motion, lateral boundary configuration, bottom topography, lateral diffusion of momentum, and various types of bottom friction. The effects of each of these terms in the equations are studied in detail before proceeding to more sophisticated models.

The general features of the winter circulation of the lake are found to be in agreement with the steady state results obtained by Rao and Murty of the Marine Sciences Branch, Ottawa. The bottom topography represents the dominant factor in determining the flow pattern. Under the prevailing westerly winds the circulation consists of eastward flow in the shallow northern part of the lake, a very strong and narrow eastward flow along the American shore of the lake, and a westward return flow in the deep central parts of the lake. The jet along the southern shore of the lake has a width of less than 10 km and therefore can just barely be resolved by the finest grid presently used. The strength of the jet depends strongly on the various modelling approximations used in any one model and therefore represents a major subject of study.

Nearshore Current Prediction

Since measurements of nearshore currents do not exist for most of the locations in the Great Lakes, a study was initiated to assess the possibility of predicting them from weather information. Results to date show that the present current component parallel to the shore-line can be predicted with a usable degree of accuracy from winds which occurred about one half day to one and a half days before. The influence of location and distance from shore is

being assessed as a further aid in generalizing the prediction model.

Okanagan Project

The Canada Centre for Inland Waters is participating in the first federal-provincial agreement signed for the purpose of providing scientific information to intelligently manage a major regional water resource. In this case, Canada and British Columbia embarked on a joint program of scientific research in the Okanagan Valley in the interior of British Columbia.

This past year, CCIW has conducted its first of nine monitor cruises in Lakes Okanagan, Osoyoos, Skaha, Woods and Kalamalka. Those cruises are designed to provide base line data on (1) the present nutrient levels in these lakes, (2) the amounts of heat absorbed by these lakes and its manner of distribution, and (3) the ability of the lakes to transmit light down to their deeper portions. All the limnological work was conducted from two seventeen foot outboard boats outfitted with winches, water sampling gear, bathythermographs and instruments designed to measure light transmission through water. Field office and warehouse facilities were set up in Penticton, B.C., which will serve as headquarters for the duration of the study.

Remote Sensing (see also Thermal Plume Studies, above)

In May and July a study was undertaken to investigate the time scale of dominant thermal features on the surface of Lake Ontario. Infrared imagery in the 8-13 micron atmospheric window was taken with a modified Reconofax IV scanner mounted in a light aircraft. The overflights were planned to coincide with the thermal bar study off Oshawa. Hence, ground truth was available from ships in the area. Ground truth was also provided by a Barnes PRT-5 radiometer, in the aircraft. An example of the imagery is shown in Figure 8.

Some investigations into multi-spectral photography continued. Two CF-100 missions were scheduled through the Program Planning Office, Ottawa, in July and October. The July mission coincided with a NASA high altitude photographic experiment on satellite simulation studies, organized through IFYGL co-ordination.

In February of 1970 an investigation unit went to Chedabucto Bay in Nova Scotia to observe the oil spill from the grounded tanker ARROW. Flights were made over the bay with the Reconofax IV infrared scanner, and some multispectral photography was also taken over the polluted areas. Figure 10 shows an example of the oil off the coast as it appears in the spectral range 340 – 480 mm.

Table I contains a summary of remote sensing missions flown for the CCIW program.

Representation from the Physical Limnology Section was included on committees recommending on Canadian plans for remote sensing, including the forthcoming U.S. Earth Resources Technology Satellite series. This particular involvement is through a Water Resources Working Group which reports to the Program Planning Office of the Interdepartmental Committee on Resource Satellites and Remote Airborne Sensing.

Monitor Program – Great Lakes

Preliminary charts of surface distribution of tempera ture, dissolved oxygen content, conductivity and turbidit were made up after every monitor cruise and distributed t interested persons and agencies. A sample of the charts i contained in Figure 11.

Coastal Temperature Program – Great Lakes

Instrumentation for measuring water temperature at th surface and bottom of the lakes just offshore has bee designed by the Engineering Systems Section. Two unit have been assembled and installed by the Technica Operations Section and are in operation at Oshawa and P Petre. Five more units are to be built and installed durin 1971 at Kingston, Cobourg, Toronto headland, Burlingto and Port Weller.

Great Lakes Data Atlas

A Summary Data Atlas which provides information c averages and ranges of certain data, by month, is near completed for Lake Ontario. Similar presentations, f others of the Great Lakes, are being developed.

Current Monitoring

In 1970, a current monitoring program was initiated study the statistical properties of nearshore lake currents certain select locations in Lake Ontario. Measurements we carried out over the whole year, to assess the curre regimes during different seasons. The chosen locations we Kingston, Oshawa, Long Branch near Toronto, Hamilt and the mouth of the Niagara River. The results, to published in a technical report, are aimed at providi information useful in the planning of municipal works.

Oil/Water Studies

A program was commenced, at year's end, in the fi d of oil pollution in lakes. Initial efforts have been spent n acquiring latest information on oil spill containment a d cleanup. A modest oil/water research program is anticipa d during the following year.

Figure 10. Oil spill in Chedabucto Bay, Nova Scotia, Feb. 1970. Spectral range 340 - 480 mm.

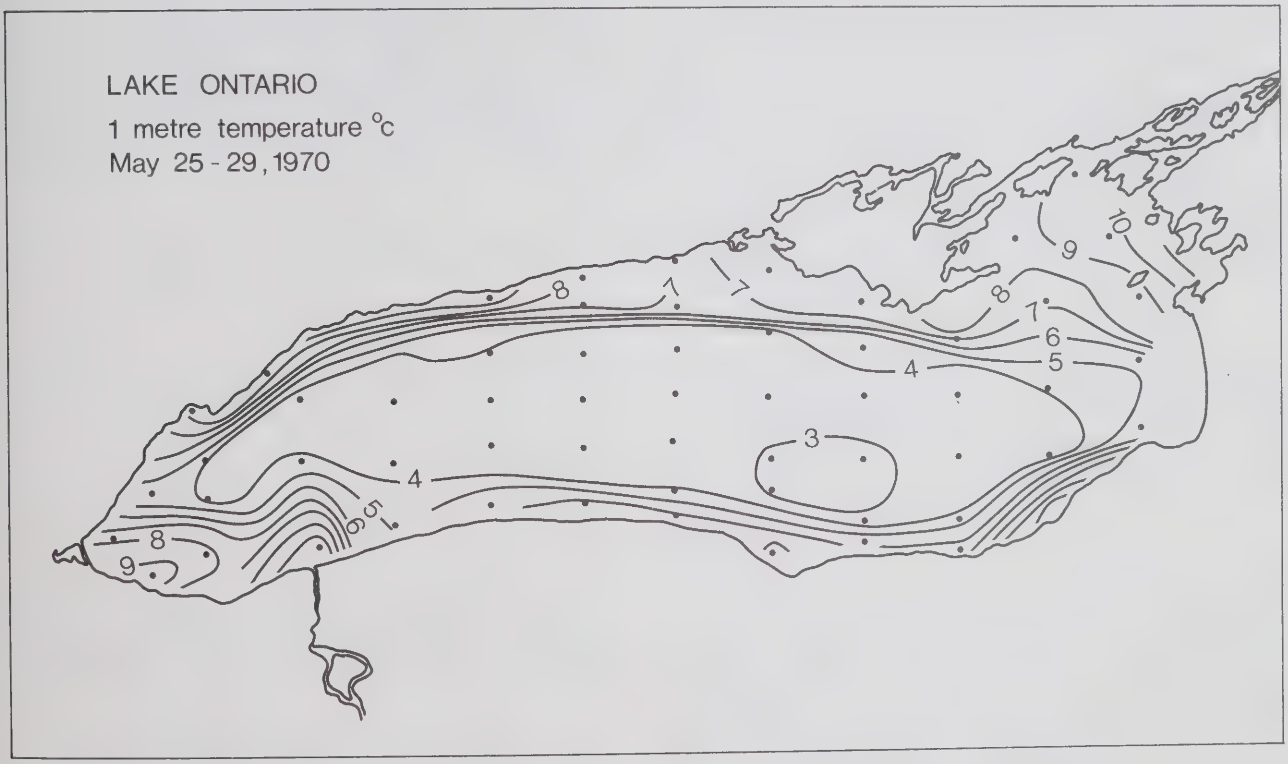


Figure 11.

LIMNOGEOLOGY SECTION

The Limnogeology Section is responsible for undertaking research on the bottom sediments and suspended particulate material in major Canadian lakes and their interconnecting waterways.

Mercury Studies

As part of a series of on-going studies on heavy metals in sediments, a number of sampling programs were under-

TABLE I
C.C.I.W. REMOTE SENSING PROGRAMME 1970

DATE	AIRCRAFT	SENSOR	GROUND TRUTH	LOCATION OR PROJECT
19 OCT	NASA RB 57	MULTI SPECTRAL PHOTOGRAPHY	SHIP DATA	LAKE ONTARIO
10 OCT	CF100	THERMAL SCANNER MULTI SPECTRAL PHOTOGRAPHY	SHIP DATA	LAKE ONTARIO
OCTOBER	PIPER	PRT-5	————	THERMAL PLUME STUDIES LAKEVIEW PLANT
16 JULY	SPARTAN	THERMAL SCANNER	SHIP DATA	OSHAWA
6 JULY	CF100 AND NASA RB57	MULTI SPECTRAL PHOTOGRAPHY	————	LAKE ONTARIO
20 MAY	SPARTAN	THERMAL SCANNER PRT-5	SHIP DATA	OSHAWA
14 MAY	SPARTAN	THERMAL SCANNER PRT-5	SHIP DATA	OSHAWA
14 FEB	NORTH STAR	THERMAL SCANNER MULTISPECTRAL PHOTOGRAPHY	————	CHEDABUCTO BAY NOVA SCOTIA

taken in the following areas: the upper St. Lawrence, between Cornwall and Kingston; the Kingston basin (with special reference to the Charity Shoal, Wolfe Island and Cape Vincent areas); fill-in sampling at scattered locations along the southern shore of Lake Ontario; and Lake St. Clair. Samples taken in 1967, 1968 and 1969, in Lake Huron, Lake Ontario and the Niagara River are also being analyzed. Results show that, at present, input of mercury, into Lake Ontario, comes mainly from the Niagara River. Mercury levels remain relatively high along the south shore of the lake, and possibly receive further enrichment from sources on the United States shore. High mercury levels in sediments from the Wolfe Island – Cape Vincent area were also recorded. Sediments in the Adolphus Reach may also have an increased content of mercury (due to both natural sources and industrial discharge). A core sample from Lake Ontario shows that concentrations of mercury began to exceed background levels in very recent times, probably about 1915. Further, and more dramatic increases occur during the 1939 to 1945 period after which values have continued to rise, though less steeply, up to the present. Mercury levels of more than four times that of the background values have been recorded in sediments of recent years.

Organic Geochemistry

Work has continued on the estimation of sedimentation

Figure 12. Calibrating and setting up the radio navigation system for nearshore studies, using a tellurometer.

rates, using the *Ambrosia* horizon as a marker and datum plane. Most recent estimates for the eastern, central and western basin of Lake Erie give values of 8.2, 4.4 and 0.9 mm/year. In Lake Ontario, a rate of 1.0 mm/year has been estimated for the eastern basin, but mean accumulation rates of up to 1.3 mm/year seem likely.

Studies on the occurrence of chlorophyll in the lake sediments show that Chl_a is usually degraded to pheophytin *a* and pheophorbide *a*; the lack of Chl_b suggests that most of the organic matter is autochthonous.

Humic acids in the surface sediments of Lakes Erie, Huron and Ontario appear to be similar to those found in sub-aerial soils. The humic and fulvic acids closely resemble those of tundra type soils.

Studies on the occurrence of extractable phosphate in the surface sediments of Lakes Ontario and Erie suggest that if, under the worst possible conditions, all of it were to be returned back to the lake water, it would represent only 4 per cent in Lake Ontario and 26 per cent in Lake Erie, of the present-day level of phosphate in the water.

Tests were continued on the suitability of various lake bottom sediments for agricultural usage. The growth of experimental tomato plants indicated that Hamilton Harbour and Lake Ontario muds were superior to the comparison top-grade agricultural soil and that Lake Erie muds were equivalent. Further results, however, suggest that the muds require at least 1 year's cultivation to develop a suitable tilth.

Nearshore and Shoreline Studies

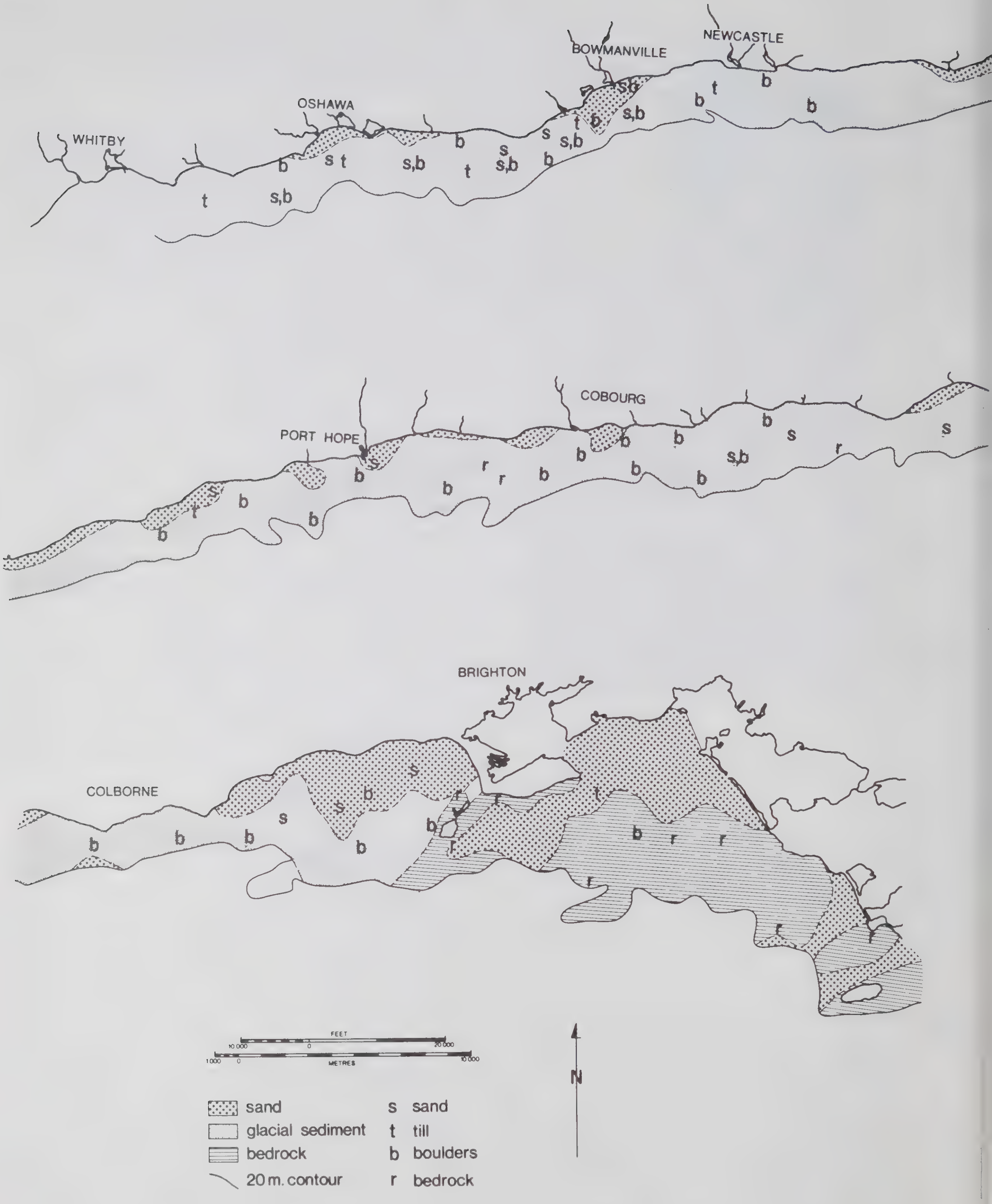
Sediment inventory surveys were continued along the north shore of Lake Ontario and were extended eastwards from Scotch Bonnet Island to Wicked Pt. (Figure 12) As in previous surveys of the north shore of Lake Ontario, the cover of recent sediments over bedrock was found to be extremely thin and bedrock outcrops were exposed at several locations. The only major developments of recent sandy deposits were found in the Dobbs Bank, Willington and Athol Bay areas. A similar survey was commenced in eastern Lake Erie and sampling was completed between Fort Erie and Mohawk Pt. (Figure 13). East of Pt. Colborne, bedrock occurs inshore and medium-fine sand offshore. West of Pt. Colborne bedrock occurs inshore, glacial till and lag deposits at shallow depths and medium-coarse sands in the off-shore areas. Glacio-lacustrine sediments were found at depths of 20 m and more. About 650 km of survey line were run and about 150 sample locations were occupied.

Kingston Basin Area

Several sediment inventory surveys were undertaken in the extreme eastern end of Lake Ontario. These involved about 1500 km of soundings and sampling and coring (Figure 14) at some 340 pre-selected locations. Studies were made on the distribution and type of bottom sediments, their associated fauna, and thickness and type of post-glacial materials.

Pt. Pelee Studies

An intensive study of erosion and sediment movement at Pt. Pelee, Lake Erie, initiated in 1970, was developed in co-operation with the Ontario Department of Lands and Forests. The first phase of this program involved a study of the shoreline and nearshore area from Wheatley, westwards, as far as Willowwood (near the Detroit River). Sampling and soundings were made along 20 traverse lines (perpendicular to the shore), each about 2 km in length. In addition, tracer studies were attempted, south of Pelee Pt., using dyed sand implacements.



WHITBY
OSHAWA
BOWMANVILLE
NEWCASTLE
PORT HOPE
COBOURG
BRIGHTON
COLBORNE
FEET
METRES
N
sand
glacial sediment
bedrock
20 m. contour
s sand
t till
b boulders
r bedrock

Figure 13.

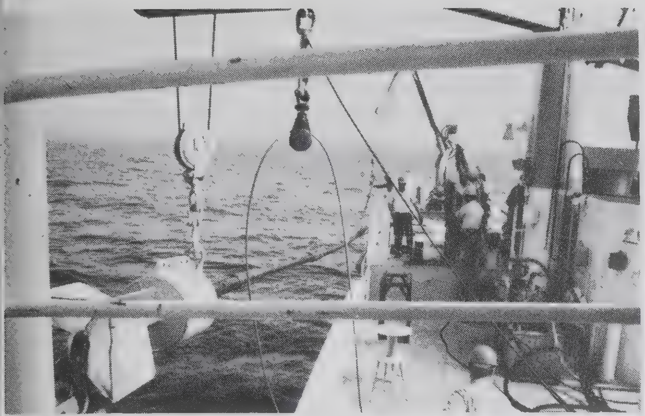


Figure 14. Coring operations, using an Alpine 1200 lb. piston corer, aboard the C.S.S. Limnos, Charity Shoal, Lake Ontario.

Toronto Offshore Study

A continuous seismic reflection survey was completed in the area immediately offshore, between Humber Bay and Highland Creek (Scarborough). Echo sounding and previous sampling programs (covering this area) provided data on the surficial material. Bedrock was found to be at a depth of about 30 m below lake level near the Toronto Islands, and at a depth of 10 to 15 m at the eastern end of the area. Two major buried bedrock valleys were identified. One aligned approximately along the Humber River (at a depth of 15 to 20 m near shore) and traceable to a point about 4 km south of the SE entrance to Toronto Harbour, where it reaches a depth of about 110 to 120 m below lake level. The other valley runs southward from the shoreline at Victoria Park Avenue at a depth of 10 to 15 m and joins with the proto-Humber Valley, SSE of the Toronto Islands, at a depth of about 110 m. This program was undertaken jointly by the Limnogeology Section and the Geological Survey of Canada.

Submersible Operations

In May, 1970, the Canadian Armed Forces Submersible PISCES III (Figure 15) was used for a number of trial dives and operational evaluations in the Tobermory area of Georgian Bay and around Pt. Pelee in Lake Erie. A number of government (federal and provincial) departments were involved, together with universities and industry. The University of Michigan (Ann Arbor) also participated. Observations and interpretations of bedrock outcrops, sediment type and environmental conditions were successfully made at a number of locations. Weather conditions were, however, far from ideal and the support craft (35 m barge with deck-mounted crane and a 20 m tug) were restricted to sheltered locations for launch and recovery of the submersible. The potential of submersibles for some

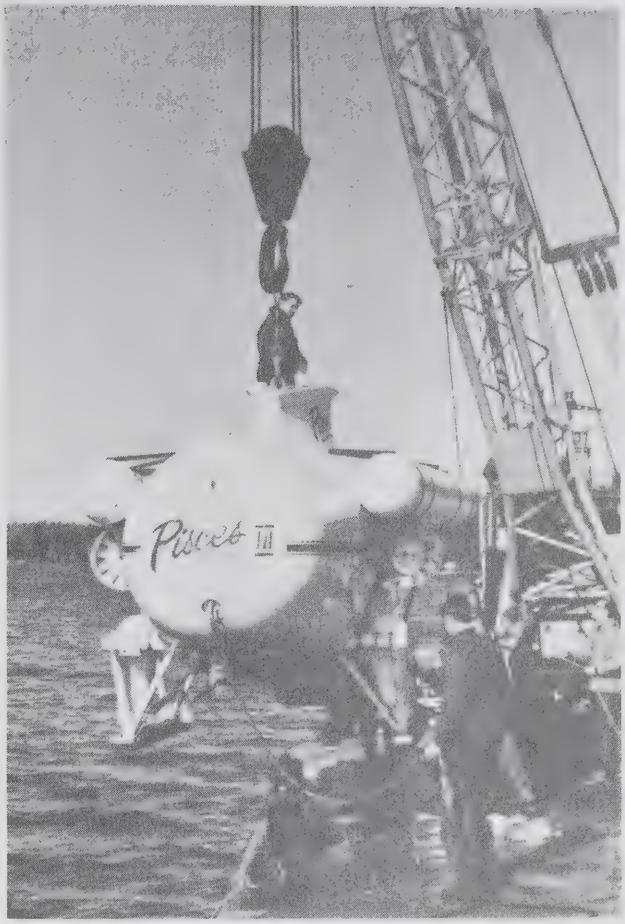


Figure 15. The submersible PISCES III being launched from the barge HANDY BOY, Georgian Bay, May 1970.

specially selected research programs appears high.

Equipment

A number of items of equipment were designed and built to meet requirements, (see also report of Engineering Systems Section). A triple corer with precision extruder was developed for geochemical sampling, and can be used from all but the smallest of launches. A portable coring winch and tripod was designed specifically for through-ice sampling on frozen lakes. It is operational in temperatures down to -40°C; it can lift 400 kg (under gasoline power) and can "break-out" a load in excess of 1,000 kg (under manual power). The whole assembly is trailerable by snowmobile and can be flown into remote locations by light aircraft. A vibro-corer system using a pneumatic source, was developed for coring sandy sediments; radiographs have shown minimum sediment disturbance. Modifications to the continuous seismic reflection profiling equipment were completed. The recorder, which is

compatible with either boomer or air-gun sources, has been coupled with a magnetic recorder which tapes unfiltered signals that can be replayed with any filter combinations for future analysis. A new boomer source should provide excellent discrimination of shallow reflectors. Development has continued with an UW time-lapse photographic system to record sediment movement in the nearshore zone. Trials, in Georgian Bay, appeared very promising. Tests with a suspended-load pumping and continuous centrifuging system in the east end of Lake Ontario showed that more than 80 per cent of the material recovered (above 0.01μ) was organic. Construction has been started on a new sedimentology trailer for use as a field laboratory and designs for a new, trailerable, shallow-water coring platform are currently under study.

Contracts

The Geology Department of Lakehead University continued a geological survey of the nearshore and shoreline areas of the Canadian shoreline of Lake Superior, under contract to CCIW. Studies of the Thunder Bay and Black Bay areas were completed.

Barringer Research, Toronto, provided analytical services to the inorganic geochemistry unit of the Section, specifically for the identification of mercury by means of an interference-free mercury spectrometer. Several hundred analyses have been completed.

TECHNICAL OPERATIONS SECTION

Major Ships

The Section continued to use the two major vessels, C.S.S. LIMNOS and the charter vessel M.V. MARTIN KARLSEN, as in the previous year, for scientific data collection and monitoring work. The monitoring of the upper lakes was augmented from time to time by the C.G.G.S. PORTE DAUPHINE, Ministry of Transport through contract arrangements with Great Lakes Institute, University of Toronto.

C.S.S. LIMNOS carried out many varied cruises using a variety of scientific equipment. Included in these operations was project “HYPO” (the Hypolimnion Project, Lake Erie) and a series of instrument development cruises which were coincident with remote sensing overflights on Lake Ontario. The mechanical problems which had plagued the ship in 1969 were seemingly ironed out, resulting in better performance and little down time.

M.V. MARTIN KARLSEN continued to be the workhorse of the fleet in monitor work, being in continuous operation throughout the year and completing four cruises on Lake Ontario during the winter months which was a new departure for CCIW operations.

C.C.G.S. PORTE DAUPHINE was under contract when our major ships were unavailable for monitor cruises on the upper Great Lakes. These cruises, staffed by the Great Lakes Institute, were co-ordinated by Technical Operations and complemented our regular monitor program in these areas.

Minor Ships

C.S.S. RADEL II was based at CCIW, on call for coastal spills and engineering development, scientific tower erection and thermal surveys. This vessel also undertook CCIW’s first pesticide study for the Environmental Quality Co-ordination Unit in Lakes Ontario and Erie which incorporated new trawling techniques for CCIW in ground fishing.

The chartered tug M.V. LAC ERIE was used mainly on Mini-Fix surveys for the Limnogeology Section, sampling sediments in the Kingston Basin area. Earlier in the summer she assisted during submersible operations at Tobermory and Lake Erie.

Small Craft

The Technical Operations Section continued to co-ordinate, through Central Region, Marine Sciences Branch, the assignment of the fleet of small craft to various Sections

OPERATIONAL TABLE 1970

Ship	Commenced Operations	Completed Operations	Miles Steamed	Total Active Days	Days on Survey	Percen
C.S.S. LIMNOS	March 16	December 14	15,741	272	171	62.5
M.V. MARTIN KARLSEN	January 6	December 19	28,373	291	224	76.4

(complete schedules are given in Tables II and III)

at CCIW, universities and outside agencies.

Personnel

Personnel from the Section were assigned to major and minor ships on a continuing basis throughout the season, and to small craft involved with shore-based scientific survey parties. These surveys were based at Oshawa, Erieau, Kingston and the Okanagan.

The staff were responsible for all deck observations, field equipment and co-ordination of vessel movements. Routine meteorological observations and reports were also carried out by this group and transmitted regularly to Meteorological Branch forecast centres. Both major ships were given a Group Award for excellence in marine weather reporting for this function.

Eight student assistants were employed by the Section during the summer season on field operations.

Okanagan Basin Project

Two Operations personnel co-ordinated and carried out the main sampling program in the Okanagan Basin Pilot Study. This was a fall operation, carried out specifically to evaluate problems which could conceivably occur during the 1971, eight month Okanagan area field survey. The work also provided a great deal of important and heretofore unknown limnological data about the lakes in the basin.

Submersible Operation

The submersible PISCES III was used in the Georgian Bay/Tobermory area in early May. Two Operations personnel co-ordinated activities of the various agencies concerned with diving in the craft, and with the movement and control of equipment, which consisted of auxiliary craft, the tug LAC ERIE, barge HANDY-BOY and a Jet Ranger helicopter. The craft itself was operated by Canadian Armed Forces personnel.

The depths in which the vehicle was used ranged from 30 feet in Big Tub Harbour, to 250 feet in Georgian Bay. This program was continued in Lake Erie from Kingsville to Erieau in late May, before return of the submersible to the Canadian Armed Forces on the East Coast.

Diving Section

A Senior Diving Officer was taken on strength in early spring. His main duties have been direction of all diving at CCIW, and the supervision of all outside diving contracts. In addition, a "Diving Policy" and Manual has been drafted which is a policy directive setting forth requirements to be adhered to by all persons who will be diving as part of their duties with CCIW.

The Senior Diving Officer, together with contract divers and Technical Operations personnel, erected towers in lake locations at Kenora and Hamilton Beach for measurement of water conditions and related meteorological factors. Many other underwater studies and techniques have also been undertaken and assistance was given to the Central Region, MSB fleet from time to time.

Miscellaneous

Technical Operations staff co-operated on several occasions with the Environmental Quality Co-ordination Unit in investigating reports of oil spills and leakages. It is anticipated that these emergencies will continue to be met in an increased amount by this Section with the naming of CCIW as the Regional Co-ordination Centre for the federal contingency plan on the Great Lakes.

During the year a new measure was instituted whereby scientific observers accompanied Technical Operations staff on monitor cruises to observe and suggest modifications of sampling techniques and other operations.

Personnel from several agencies, such as CODC and Data Quality Control Unit, who prepare data from cruise reports for reports, took part in several monitor cruises as part of a training program whereby their personnel were given a first hand look at how the field data are being collected, measured and analyzed.

A new experimental "floating" tower was successfully tested off Hamilton Beach during the summer survey season. This tower, developed by Technical Operations, and known as a Self Mooring Platform (S.M.P.) was towed floating to a pre-arranged position and sunk by opening the sea-cocks. The S.M.P. was used for housing meteorological instruments from spring until late fall by the Physical Limnology Section, who reported that the tower was very stable and the test most successful. Compressed air was blown into the ball-shaped cylinders to re-float the tower and it was towed back to CCIW in late fall.

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES (IFYGL) CENTRE

CCIW continued to provide staff and facilities for the IFYGL (Canadian Co-ordinator's Office). The IFYGL is a comprehensive synoptic study of the Lake Ontario Basin, with five major scientific sub-programs to investigate the details of the physical limnology, the basin meteorology, the lake energy budget and radiation climate, the terrestrial water budget and hydrology of the basin, and the biology and chemistry of the lake. Planning discussions have continued since 1965, but commitments to the program have only recently been made in Canada and the United

GREAT LAKES STUDIES – 1970 – CSS LIMNOS

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	4	5	6	7	8	9	10
JANUARY	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
	1	2	3	4	5	6	7
FEBRUARY	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
MARCH	15	16 Depart CCIW 1000 hrs	17 Benthos Coring Lake Ontario	18 Benthos Coring Lake Ontario	19 Benthos Coring Lake Ontario	20 Arrive CCIW 0840 hrs.	21 CCIW
	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW
	29 CCIW	30 CCIW	31 CCIW	1 Depart CCIW 1000 hrs. In transit	2 Mooring Cruise Lake Erie	3 Mooring Cruise Lake Erie	4 Mooring Cruise Lake Erie
	5 Arrived Sarnia 1740 hrs	6 Sarnia	7 Sarnia	8 Sarnia	9 Depart Sarnia 1100 hrs	10 Mooring Cruise Lake Huron	11 Mooring Cruise Lake Huron
APRIL	12 Mooring Cruise Lake Huron	13 Mooring Cruise Lake Huron	14 Mooring Cruise Lake Huron	15 Mooring Cruise Lake Huron	16 Arrived CCIW 0200 hrs	17 Depart CCIW 1000 hrs	18 Mooring Cruise Lake Ontario
	19 Mooring Cruise Lake Ontario	20 Arrive CCIW 1410 hrs	21 CCIW	22 CCIW	23 CCIW	24 Departed for Dry Dock	25 Dry Dock
	26 Dry Dock	27 Dry Dock	28 Dry Dock	29 Dry Dock	30 Dry Dock	1 Dry Dock	2 Dry Dock
	3 Dry Dock	4 Dry Dock	5 Dry Dock	6 Dry Dock	7 Dry Dock	8 Dry Dock	9 Dry Dock
MAY	10 Dry Dock	11 Dry Dock	12 Dry Dock	13 Dry Dock	14 Arrived from Dry Dock	15 Depart CCIW 0100 hrs	16 Time Series Lake Ontario
	17 Time Series Lake Ontario	18 Time Series Lake Ontario	19 Time Series Lake Ontario	20 Time Series Lake Ontario	21 Time Series Lake Ontario	22 Arrived CCIW 1250 hrs	23 CCIW
	24 CCIW	25 Depart CCIW 1155 hrs	26 Time Series Lake Ontario	27 Time Series Lake Ontario	28 Time Series Lake Ontario	29 Time Series Lake Ontario	30 Arrived CCIW 0850 hrs
	31 CCIW	1 Depart 1040 hrs Time Series Ont.	2 Arrived CCIW 2235 hrs	3 CCIW	4 CCIW	5 CCIW	6 CCIW
JUNE	7 CCIW	8 CCIW	9 Depart CCIW 1620 hrs	10 Moorings & Echo Sounding L. Ont.	11 Moorings & Echo Sounding L. Ont.	12 Arrived CCIW 1840 hrs	13 CCIW
	14 CCIW	15 Depart CCIW 1200 hrs	16 Horz. Turbulence Meas. W. L. Ont.	17 Horz. Turbulence Meas. W. L. Ont.	18 Arrived CCIW 1830 hrs	19 CCIW	20 CCIW
	21 CCIW	22 Depart CCIW 1000 hrs	23 Mooring Cruise Lake Ontario	24 Mooring Cruise Lake Ontario	25 Arrived CCIW 1825 hrs	26 CCIW	27 CCIW
	28 CCIW	29 CCIW	30 CCIW	1 CCIW	2 Depart CCIW 1000 hrs	3 Inst. Development Lake Ontario	4 Inst. Develop. Lake Ontario
	5 Inst. Develop. Lake Ontario	6 Inst. Develop. Lake Ontario	7 Inst. Develop. Lake Ontario	8 Inst. Develop. Lake Ontario	9 Inst. Develop. Lake Ontario	10 Arrived CCIW 1450 hrs	11 CCIW
JULY	12 CCIW	13 Depart CCIW 1020 hrs	14 Inst. Develop. Lake Ontario	15 Inst. Develop. Lake Ontario	16 Inst. Develop. Lake Ontario	17 Inst. Develop. Lake Ontario	18 Arrived CCIW 1905 hrs
	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 OECD Cruise	24 CCIW	25 CCIW
	26 Depart CCIW 1953 hrs Canal Trans.	27 Project HYPO Lake Erie	28 Project HYPO Lake Erie	29 Project HYPO Lake Erie	30 Project HYPO Lake Erie	31 Project HYPO Lake Erie	1 Project HYPO Lake Erie
	2 Project HYPO Lake Erie	3 Project HYPO Lake Erie	4 Project HYPO Lake Erie	5 Project HYPO Lake Erie	6 Project HYPO Lake Erie	7 Project HYPO Lake Erie	8 Project HYPO Lake Erie
AUGUST	9 Project HYPO Lake Erie	10 Project HYPO Lake Erie	11 Project HYPO Lake Erie	12 Project HYPO Lake Erie	13 Project HYPO Lake Erie	14 Project HYPO Lake Erie	15 Project HYPO Lake Erie
	16 Project HYPO Lake Erie	17 Project HYPO Lake Erie	18 Project HYPO Lake Erie	19 Project HYPO Lake Erie	20 Project HYPO Lake Erie	21 Project HYPO Lake Erie	22 Project HYPO Lake Erie
	23 Project HYPO Lake Erie	24 Project HYPO Lake Erie	25 Project HYPO Lake Erie	26 Arrived CCIW 2145 hrs	27 CCIW	28 CCIW	29 CCIW
	30 CCIW	31 Depart CCIW 1200 hrs	1 Mooring Cruise Lake Ontario	2 Mooring Cruise Lake Ontario	3 Arrived CCIW 1440 hrs	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 Depart CCIW 0852 Canal Transit	9 Mooring Cruise Lake Huron	10 Mooring Cruise Lake Huron	11 Mooring Cruise Lake Huron	12 Mooring Cruise Lake Huron
SEPTEMBER	13 Mooring Cruise Lake Huron	14 Mooring Cruise Lake Huron	15 Mooring Cruise Lake Huron	16 Mooring Cruise Lake Huron	17 Mooring Cruise Lake Huron	18 Arrived CCIW 1930 hrs	19 CCIW
	20 CCIW	21 Depart CCIW 1040 hrs	22 Coring & Echo Sounding L. Ont.	23 Coring & Echo Sounding L. Ont.	24 Coring & Echo Sounding L. Ont.	25 Arrived CCIW 0640 hrs	26 CCIW
	27 CCIW	28 CCIW	29 Depart CCIW 0043 hrs	30 Inst. Develop. Lake Ontario	1 Inst. Develop. Lake Ontario	2 Inst. Develop. Lake Ontario	3 Inst. Develop. Lake Ontario
	4 Inst. Develop. Lake Ontario	5 Inst. Develop. Lake Ontario	6 Inst. Develop. Lake Ontario	7 Inst. Develop. Lake Ontario	8 Inst. Develop. Lake Ontario	9 Arrived CCIW 0500 hrs	10 CCIW
OCTOBER	11 CCIW	12 CCIW	13 Depart CCIW 0925 Canal Transit	14 Mooring Cruise Lake Erie	15 Mooring Cruise Lake Erie	16 Arrive CCIW 0415 hrs	17 CCIW
	18 CCIW	19 Depart CCIW 1015 Inst. Develop.	20 Arrive CCIW 1905 Lake Ontario	21 Depart CCIW 2356 hrs	22 Coring & Special Lake Ontario	23 Coring & Special Lake Ontario	24 Coring & Special Lake Ontario
	25 Arrive CCIW 0650 hrs	26 CCIW	27 Depart CCIW 0840 hrs	28 Mooring Lake Ontario	29 Mooring Lake Ontario	30 Mooring Lake Ontario	31 Mooring Lake Ontario
	1 Mooring Lake Ontario	2 Mooring Lake Ontario	3 Mooring Lake Ontario	4 Mooring Lake Ontario	5 Mooring Lake Ontario	6 Arrive CCIW 1449 hrs	7 CCIW
	8 CCIW	9 CCIW	10 CCIW	11 Port Weller Dry Dock	12 Port Weller Dry Dock	13 Arrived CCIW 1545 hrs	14 CCIW
NOVEMBER	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 0835 hrs	25 Mooring Lake Huron	26 Mooring Lake Huron	27 Mooring Lake Huron	28 Mooring Lake Huron
	29 Mooring Lake Huron	30 Arrive Windsor 1240 hrs	1 Depart Windsor 0613 hrs	2 Mooring Lake Erie	3 Mooring Lake Erie	4 Arrive CCIW 0210 hrs	5 CCIW
DECEMBER	6 CCIW	7 Depart CCIW 1000 hrs	8 Mooring Lake Ontario	9 Mooring Lake Ontario	10 Mooring Lake Ontario	11 Mooring Lake Ontario	12 Mooring Lake Ontario
	13 Mooring Lake Ontario	14 Arrive CCIW 1500 hrs	15 END	16 OF	17 FIELD	18 SEASON	19

GREAT LAKES STUDIES – 1970 – MV. MARTIN KARLSEN

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JANUARY	4 CCIW	5 CCIW	6 Depart CCIW 1515 hrs	7 Monitor Lake Ontario	8 Monitor Lake Ontario	9 Monitor Lake Ontario	10 Monitor Lake Ontario
	11 Monitor Lake Ontario	12 Arrive CCIW 0955 hrs	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 CCIW	24 CCIW
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW
FEBRUARY	1 CCIW	2 CCIW	3 Depart CCIW 1542 hrs	4 Monitor Lake Ontario	5 Monitor Lake Ontario	6 Monitor Lake Ontario	7 Monitor Lake Ontario
	8 Monitor Lake Ontario	9 Arrive CCIW 0940 hrs	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW
MARCH	1 CCIW	2 CCIW	3 Depart CCIW 1400 hrs	4 Monitor Lake Ontario	5 Monitor Lake Ontario	6 Monitor Lake Ontario	7 Monitor Lake Ontario
	8 Monitor Lake Ontario	9 Arrive CCIW 0900 hrs	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 Depart CCIW 1050 hrs	24 Mooring Lake Ontario	25 Mooring Lake Ontario	26 Arrive CCIW 1145 hrs	27 CCIW	28 CCIW
	29 CCIW	30 CCIW	31 Depart CCIW 1505 hrs	1 Monitor Lake Ontario	2 Monitor Lake Ontario	3 Monitor Lake Ontario	4 Monitor Lake Ontario
APRIL	5 Arrive CCIW 1240 hrs	6 Depart CCIW 1535 hrs	7 Monitor Lake Erie	8 Monitor Lake Erie	9 Monitor Lake Erie	10 Monitor Lake Erie	11 Arrive Sarnia 1633 hrs
	12 Sarnia	13 Depart Sarnia 1645 hrs	14 In Transit	15 Monitor Lake Superior	16 Monitor Lake Superior	17 Monitor Lake Superior	18 Monitor Lake Superior
	19 Monitor Lake Superior	20 Monitor Lake Superior	21 Monitor Lake Superior	22 Monitor Lake Superior	23 Monitor Lake Superior	24 Transit	25 Arrive CCIW 1910 hrs
	26 CCIW	27 CCIW	28 Depart CCIW 1000 hrs	29 Monitor Lake Ontario	30 Monitor Lake Ontario	1 Monitor Lake Ontario	2 Arrive CCIW 1600 hrs
MAY	3 CCIW	4 CCIW	5 Depart CCIW 1100 hrs	6 Monitor Lake Erie	7 Monitor Lake Erie	8 Monitor Lake Erie	9 Monitor Lake Erie
	10 Arrive Sarnia 2100 hrs	11 Depart Sarnia 1800 hrs	12 Monitor Lake Huron	13 Monitor Lake Huron	14 Monitor Lake Huron	15 Monitor Lake Huron	16 Monitor Lake Huron
	17 Monitor Lake Huron	18 Monitor Lake Huron	19 In Transit	20 In Transit	21 Arrive CCIW 0300 hrs	22 CCIW	23 CCIW
	24 CCIW	25 Depart CCIW 0950 hrs	26 Monitor Lake Ontario	27 Monitor Lake Ontario	28 Monitor Lake Ontario	29 Arrive CCIW 1810 hrs	30 CCIW
	31 CCIW	1 Depart CCIW 1315 hrs	2 Monitor Lake Erie	3 Monitor Lake Erie	4 Monitor Lake Erie	5 Monitor Lake Erie	6 Arrive Sarnia 1615 hrs
JUNE	7 Sarnia	8 Depart Sarnia 1915 hrs	9 Mooring Lake Huron	10 Mooring Lake Huron	11 Mooring Lake Huron	12 Sarnia Arrive 1225 Dep. 1410	13 Mooring Lake Erie
	14 Mooring Lake Erie	15 Arrive Port Weller 2105 hrs	16 Dry Dock	17 Dry Dock	18 Dry Dock	19 Dry Dock	20 Dry Dock
	21 Dry Dock	22 Arrive CCIW 0700 Dep. 1620	23 Monitor Lake Ontario	24 Monitor Lake Ontario	25 Monitor Lake Ontario	26 Monitor Lake Ontario	27 Monitor Lake Ontario
	28 Arrive CCIW 1300 hrs	29 CCIW	30 CCIW	1 CCIW	2 Depart CCIW 1035 hrs	3 Monitor Lake Erie	4 Monitor Lake Erie
JULY	5 Monitor Lake Erie	6 Monitor Lake Erie	7 Monitor Lake Erie	8 Arrive CCIW 1830 hrs	9 Depart CCIW 1300 hrs	10 Dry Dock	11 Dry Dock
	12 Arrive CCIW 1000 hrs	13 CCIW	14 CCIW	15 CCIW	16 Depart CCIW 1040 hrs	17 Monitor Lake Ontario	18 Monitor Lake Ontario
	19 Monitor Lake Ontario	20 Monitor Lake Ontario	21 Arrive CCIW 0815 hrs	22 CCIW	23 OFCD Cruise	24 CCIW	25 CCIW
	26 CCIW	27 Depart CCIW 0930 hrs	28 Monitor Lake Erie	29 Monitor Lake Erie	30 Monitor Lake Erie	31 Monitor Lake Erie	1 Monitor Lake Erie
AUGUST	2 Arrive CCIW 0800 hrs	3 CCIW	4 CCIW	5 Depart CCIW 0840 hrs	6 Instrument Development	7 Arrive CCIW 1600 hrs	8 CCIW
	9 CCIW	10 Depart CCIW 0930 hrs	11 Internal Waves Lake Ontario	12 Internal Waves Lake Ontario	13 Internal Waves Lake Ontario	14 Arrive CCIW 1315 hrs	15 CCIW
	16 CCIW	17 Depart CCIW 0920 hrs	18 Monitor Lake Ontario	19 Monitor Lake Ontario	20 Monitor Lake Ontario	21 Arrive CCIW 2115 hrs	22 CCIW
	23 CCIW	24 Depart CCIW 1330 hrs	25 Monitor Lake Erie	26 Monitor Lake Erie	27 Monitor Lake Erie	28 Monitor Lake Erie	29 Monitor Lake Erie
	30 Arrive CCIW 1130 hrs	31 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW
SEPTEMBER	6 CCIW	7 CCIW	8 Depart CCIW 1130 hrs	9 Dry Dock	10 Depart Dry Dock 0230 hrs	11 Mooring Lake Erie	12 Arrive CCIW 2300 hrs
	13 CCIW	14 Depart CCIW 1230 hrs	15 Monitor Lake Ontario	16 Monitor Lake Ontario	17 Monitor Lake Ontario	18 Monitor Lake Ontario	19 Arrive CCIW 2010 hrs
	20 CCIW	21 CCIW	22 Depart CCIW 1200 hrs	23 Monitor Lake Erie	24 Monitor Lake Erie	25 Monitor Lake Erie	26 Monitor Lake Erie
	27 Arrive Sarnia 2230 hrs	28 Sarnia	29 Depart Sarnia 0800 hrs	30 Monitor Lake Huron	1 Monitor Lake Huron	2 Monitor Lake Huron	3 Monitor Lake Huron
OCTOBER	4 Monitor Lake Huron	5 Monitor Lake Huron	6 Monitor Lake Huron	7 In Transit	8 In Transit	9 Arrive CCIW 1725 hrs	10 CCIW
	11 CCIW	12 CCIW	13 Depart CCIW 1210 hrs	14 Monitor Lake Ontario	15 Monitor Lake Ontario	16 Monitor Lake Ontario	17 Arrive CCIW 1945 hrs
	18 CCIW	19 CCIW	20 Depart CCIW 1020 hrs	21 Monitor Lake Erie	22 Monitor Lake Erie	23 Monitor Lake Erie	24 Monitor Lake Erie
	25 Monitor Lake Erie	26 Arrive Sarnia 0950 Dep. 1745	27 Monitor Lake Superior	28 Monitor Lake Superior	29 Monitor Lake Superior	30 Monitor Lake Superior	31 Monitor Lake Superior
NOVEMBER	1 Monitor Lake Superior	2 Monitor Lake Superior	3 Monitor Lake Superior	4 Monitor Lake Superior	5 Monitor Lake Superior	6 Monitor Lake Superior	7 Monitor Lake Superior
	8 Monitor Lake Superior	9 Monitor Lake Superior	10 Arrive CCIW 1205 hrs	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 Depart CCIW 0925 hrs	17 Monitor Lake Ontario	18 Monitor Lake Ontario	19 Monitor Lake Ontario	20 Arrive CCIW 1745 hrs	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 0855 hrs	25 Monitor Lake Erie	26 Monitor Lake Erie	27 Monitor Lake Erie	28 Monitor Lake Erie
	29 Monitor Lake Erie	30 Monitor Lake Erie	1 Arrive CCIW 1340 hrs	2 CCIW	3 CCIW	4 CCIW	5 CCIW
DECEMBER	6 CCIW	7 Depart CCIW 2030 hrs	8 Monitor Lake Ontario	9 Monitor Lake Ontario	10 Monitor Lake Ontario	11 Monitor Lake Ontario	12 Arrive CCIW 0800 hrs
	13 Depart CCIW 1200 hrs	14 Monitor Lake Erie	15 Monitor Lake Erie	16 Monitor Lake Erie	17 Monitor Lake Erie	18 Monitor Lake Erie	19 Arrive CCIW 1200 hrs

States. The schedule is to conduct one calendar year of intensive data gathering from January 1 to December 31, 1972, preceded by instrument and technique intercomparison and trials during 1971. Data analysis, reduction and publication of results will continue through to 1974.

The primary objective of the IFYGL is to provide, through co-operation between Canada and U.S.A., a set of comprehensive "synoptic" data on one of the Great Lakes basins which will lead to a much better understanding of the lake system and to improved management of Lake Ontario, in particular, and other large lakes. It will also develop improved methods of assessing the interaction between the atmosphere and large water bodies of the world.

For some time now it has been clear that it was necessary to move from the program planning phase of the Field Year towards implementation. A Workshop held on 31 August – 2 September 1970 at McMaster University, Hamilton, punctuated this necessary move forward and gave all recently involved investigators a chance to meet and discuss matters with colleagues from both sides of the border. Presentations of the planned scientific program were also made this year at the 13th Conference for Great Lakes Research (Bolsenga, MacDowall) Buffalo, N.Y. and at the World Water Balance Conference in Reading, England (MacDowall). The objectives and program are summarized in the September 1970 issue of the Bulletin of the International Association for Scientific Hydrology (p 125-127).

During this past field season the CCIW and the Canadian Meteorological Service have worked together on the development of the deep-water meteorological buoy system for lakewide use during the IFYGL. The CCIW designed and constructed the system and then compared the performance of the meteorological observation part of the system with Canadian Meteorological Service equipment, at the CMS experimental farm near Woodbridge. The results were satisfactory to the investigators planning to use the Field Year data.

Other Field Year feasibility studies and trials undertaken by the CCIW in this season were as follows: coastal chain and diffusion studies off Oshawa (in collaboration with University of Waterloo), trials and evaluation of a towed thermistor device of the Bedford Institute, the "Batfish" thermal profiler; remote sensing using infrared scanning and photographic techniques in association with the United States National Aeronautics and Space Administration and the Geological Survey; and a theoretical analysis of the instrumentation problems and accuracy requirements of various methods of directly measuring atmospheric fluxes over the lake. Successful overflights of the western end of Lake Ontario were co-ordinated with ground work by the IFYGL Centre at CCIW on 6 July and 19 October, 1970.

The feasibility study by the Canadian Meteorological Service has continued, on the atmospheric water budget experiment, which envisages use of six radiosonde stations around the lake to measure the difference between up- and down-wind flows of water vapour across the lake. United States scientists were invited to participate, and brought their own equipment, in a three-station trial held along the shoreline of Lake Ontario from Scarborough to Burlington. This third feasibility study of the technique was conducted from 7 -18 December 1970 and used about 50 radiosonde flights to observe the horizontal variability of atmospheric winds and water vapour content. Accommodation for the U.S. scientists was provided at CCIW.

An experiment to examine the feasibility of observing lake surface temperatures from the presently orbiting ESSA satellites was conducted. Ground truth for this work was acquired by airborne radiation thermometry by the Canadian Meteorological Service. The results encourage the view that at some time in the future Lake Ontario surface temperatures may be obtained from satellites with useful accuracy and resolution, but the presently orbiting equipment is not yet suitable.

Proper management of the Great Lakes can only be based on an understanding of many interrelated processes whose seasonal changes result in the time and space variations of chemical, biological and physical factors. In order to achieve its objective, a core program in biology and chemistry was adopted at the Steering Committee meeting on 14 October 1970. This program is based on the following elements: lake-wide systematic biological observations of phytoplankton, zooplankton, fish and benthos primary productivity; the influence on the Niagara River flow in the lake's bio-chemical characteristics; the influence of the thermal bar on populations and productivity detailed nutrient and other chemical budgets of the lake the use of metals and ions as water movement and dispersion tracers; and, finally, the extension of the work in representative basins within the watershed to include consideration of the impact of basin geology and land use on nutrient and other chemical inputs to the lake. The interest of university, government and industry biologists chemists and geochemists is now being co-ordinated to develop the scientific details of this program.

A plan for the Canadian IFYGL Data Bank is being prepared by the Co-ordinator and the CCIW Computer & Data Services Section.

During the year the Co-ordinator, Mr. J. MacDowall, also acted as Vice-Chairman of the Sensor and Instrumentation Working Group of the Canadian National Inter-Agency Committee on Resource Satellites and Remote Airborne Sensing. Contracts were solicited, placed and monitored for the development in Canada of new remote sensing with a wide range of application in earth resources and environmental monitoring.

Central Region (Marine Sciences Branch)

The Marine Sciences Branch involvement at the Centre increased enormously in 1970 with the relocation of the Hydrographic activity of Central Region and the Regional Headquarters at Burlington.

HYDROGRAPHY

A field unit provided survey control and supplied and maintained navigational systems in support of Limnogeology Section programs. The support of these units also included calibration of the Minifix and Motorola systems and the production of suitable lattice charts as necessary.

The charting program of the region was continued in the Lower St. Lawrence River between Cap du Basque and Murray Bay to produce modern nautical charts for the use of commercial deep draft shipping; in the Thousand Islands area for the use of both commerce and recreational boating; and at Lake of the Woods, the Rideau Waterway, the Lake of Two Mountains for the primary purpose of producing recreational boating charts in response to public demand. In addition hydrographic surveys of small fishing harbours, were carried out on the eastern shore of Lake Superior, and many charts in Lake Superior and Lake Huron were revised and updated as part of the revisory survey cycle. Navigational ranges were surveyed in the Sorel-Quebec City

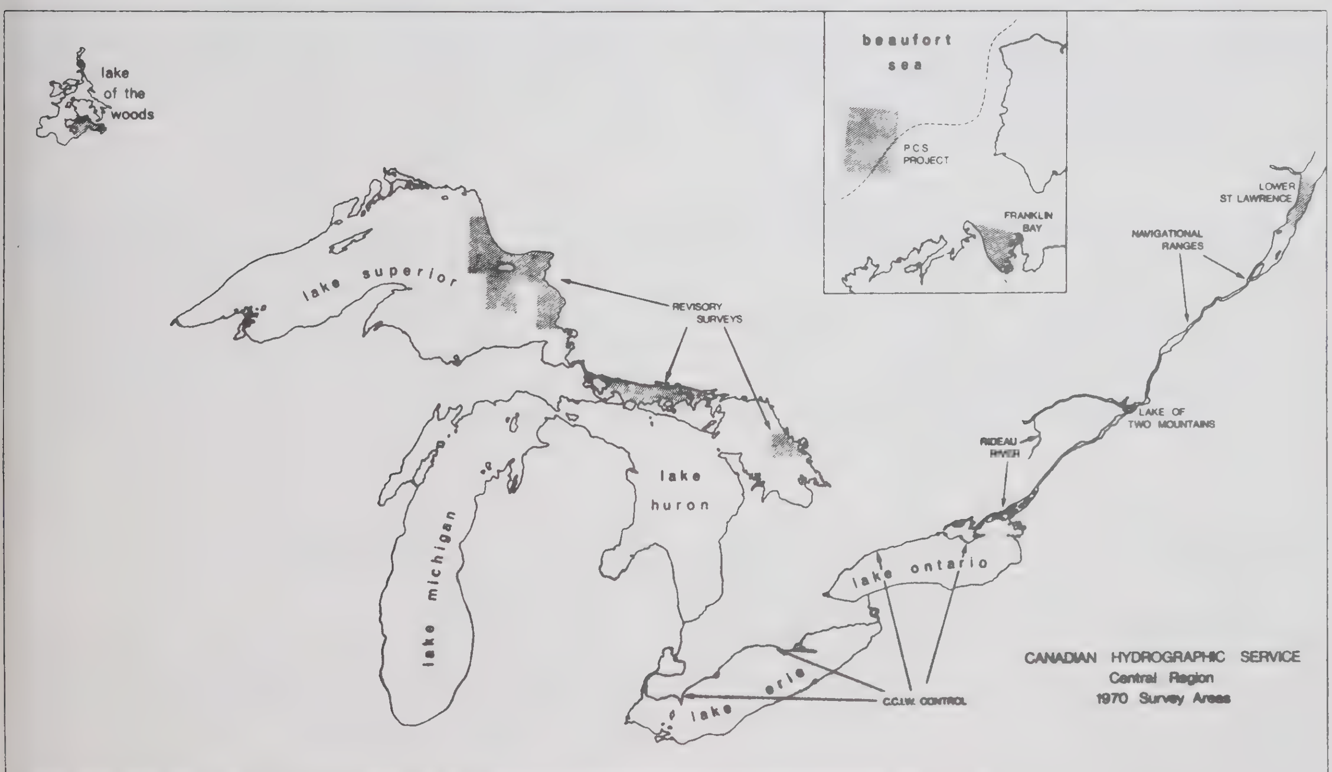


Figure 16.

area. A field unit supported Polar Continental Shelf projects in the Beaufort Sea, by carrying out bathymetric "through the ice" surveys over the continental shelf in winter, and a hovercraft survey operation and evaluation in Franklin Bay during the short summer (Figure 16).

Other hydrographic activities include preparation for IFYGL by establishing sites and survey control for the use of a navigational system covering Lake Ontario, evaluation of "accurate ranging radar" and a new type of pulse sonar.

The development group have been evaluating the Motorola system and are presently involved in a Loran C study of Lakes Ontario and Erie in conjunction with HPL Engineering Ltd. of Ottawa. In the field of data processing they have acquired a PDP 8 computer and a Gerber 22 Plotting Table and now have, for the first time, all data processing units under one roof. During 1970 all survey data used or produced by this unit and considerable additional data were processed for other field units.

SHIPS AND LAUNCHES

After completing her winter mooring schedule, MARTIN KARLSEN commenced her full time operational season March 23, continuing her predominantly monitoring operation until December 19 and suffering virtually no down time.

LIMNOS also opened the season March 23 and carried out a variety of specialized projects. She remained in service until December 14, experiencing very little down time, a much improved performance over previous years.

RADEL II, in her first operational year at CCIW saw only limited service, due mainly to her limited range and overall capability.

LAC ERIE, assigned principally to Limnogeology, enjoyed another active season from April 6 to December 22. LAC ERIE participated in the trials of the chartered D.N.D. Submersible PISCES III, supported by a branch helicopter and C.S.L. BRUCE.

Four launches were retired from service, three of them wood displacement hulls. These were replaced by Botved launches, perhaps the most suitable type of sounding launch readily available. A total of seven of these were acquired to maintain hydrographic field strength. For scientific operations, two vessels were acquired, a second Alcan 44 foot launch AGILE and a 40 foot tug W.R. MORGAN. The Alcan was found to have serious hull defects and will require extensive modification. W.R. MORGAN was acquired late in the year and will not be placed into service until 1971.

Construction was started on C.S.L. VEDETTE, a 45 foot revisory survey craft. Completion was considerably delayed, however, and the vessel is not expected to be ready for service until May, 1971.

In mid-season, the Branch accepted responsibility for the operation and maintenance of WASUCA III, a 32 foot twin-hull launch owned by the Guelph office of the Water Survey of Canada Division, Inland Waters Branch.

The Marine Workshops were occupied during the summer of 1970 and by the end of the year they were in full operation. A number of hydrographic launches and small craft were brought to the Centre for repair and refurbishment and at the close of the season the number of hulls on the premises totalled 58.

ADMINISTRATION

The administrative support section provided budgeting financial control, auditing, payroll, personnel, secretarial stores and procurement services to the region. With a manpower total to service at peak in excess of two hundred and fifty and funds to administer in excess of $3.5 million the section is kept fully occupied in ministering to regional demands.

Hydraulics Subdivision, Hydrologic Sciences Division (Inland Waters Branch)

The Hydraulics Subdivision started the year in Ottawa and moved to the Canada Centre for Inland Waters in August 1970.

Much of the earlier part of the year was devoted to planning to ensure that the proposed hydraulic laboratory at CCIW will be as versatile and as efficient as possible whil keeping costs within the budget.

The chosen areas for hydraulic activity total 7 in al These are: Calibration and Testing, Waves and Interfa Studies, Sediment Transport, Fluid Dynamics, Ice, ar

Model Studies. A considerable amount of time was devoted to designing large pieces of apparatus for each of these areas so that the building when completed would be able to accommodate them. Among the problems encountered were in the design of a large wind-wave flume and the formulation of research equipment for sediment transport studies. Other considerations were the layout of large environmental rooms for studies of ice and thermal phenomena in rivers and lakes.

Planning calls for construction to begin in April 1971 and it will take about one year to complete the structure.

One of the major responsibilities of the Subdivision is to make provision for a national calibration centre for river, lake and oceanographic current meters. During the year the Subdivision prepared the specifications for the towing carriage which will be used on the 122 metre long towing tank. Tenders were sent out for quotation in November. The carriage will be semi-automated and will embody modern control and data acquisition systems. Salient performance specifications are –

Minimum Steady Velocity	0.5 cms/sec
Maximum Steady Velocity	6.0 metres/sec.

The allowable variation in velocity is ± 1%.

During the year, the Subdivision also undertook a laboratory model study of the wave agitation in the CCIW harbour and published a report. The model studies were done in the Coastal Engineering Laboratory at Queen's University through the kind permission of Dr. A. Brebner, Head, Civil Engineering Department. Mr. J.A. Marsalek performed the tests.

In September, Dr. Y.L. Lau joined the Subdivision and began work immediately on the waste heat discharge problem as it relates mainly to rivers. The objective is to obtain an accurate method of calculating the temperature downstream of a hot water source under any conditions of river flow, depth, breadth and roughness and also the atmospheric conditions such as air temperature and wind velocity. So far the work is in the preliminary stages but several poorly known parameters such as evaporation from flowing water have been identified.

Related to thermal pollution is the problem of the reaeration of rivers and the rate at which oxygen can be supplied. Studies have begun into the relationships between the rate of reaeration and the hydraulic parameters describing the flow. In addition methods of enhancing the rate of reaeration are being investigated.

At the end of the year, a working group of the Advisory Committee to the Canada Centre was being organized to provide guidance on research priorities in hydraulics at the Centre.

During the year the Subdivision also worked closely with R.J. Kennedy and Associates on various equipment designs and on the preparation of specifications. Model tests were run at Queen's to obtain the optimum design of a large sediment trap for the sediment transport flume.

Water Quality Division (Inland Waters Branch)

During 1970 the Water Quality Division, Inland Waters Branch, was represented by two groups at CCIW, Analytical Chemistry Laboratories, and part of the Water Pollution Research Subdivision. This annual report is divided into these two main sections.

ANALYTICAL CHEMISTRY LABORATORIES

In keeping with its responsibilities for the co-ordination, planning, organization and conduct of chemical analyses of lake waters for water quality and pollution studies, as well as research and development of analytical methods for these waters; the CCIW analytical laboratories had a very busy schedule during 1970. As in the past, the detachment was actively involved in the co-ordination of analytical requests; the chemical monitoring of the Great Lakes waters and Georgian Bay, as well as providing analytical support to various other sections and/or agencies at CCIW and elsewhere.

Major projects for the year consisted of the following:

Regular Monitoring

A total of 17 full chemistry monitor cruises were completed during the year. Of these, 10 were conducted on Lake Erie, 3 on Lake Ontario and 2 each on Lakes Huron and Superior. During these cruises, approximately 3,800 water samples were analyzed aboard ship for orthophosphate, soluble reactive silica, nitrate + nitrite, ammonia and 5,000 for total alkalinity (Figure 17). A total of about 19,000 samples were analyzed for specific

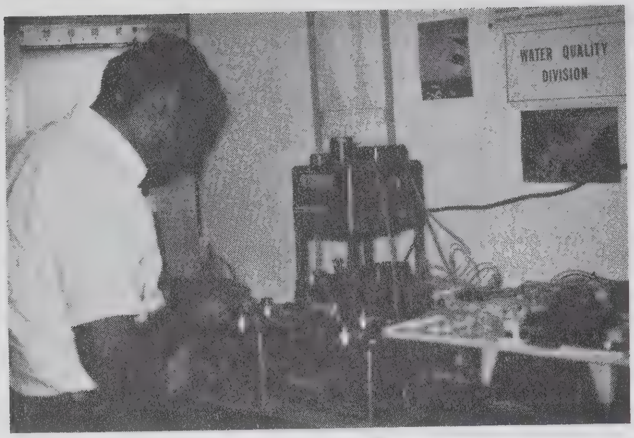


Figure 17. Multiple – Channel Auto Analyser system aboard the M.V. Martin Karlsen for simultaneous nutrients analyses of lake waters.

conductance and turbidity, 18,000 for dissolved oxygen and 16,000 for pH by the Technical Operations Section personnel. Instruments, reagents and technical supervision of these analyses were provided by the Water Quality Division detachment staff. Approximately 6,200 samples returned to the shore laboratory were analyzed for total phosphate and total organic nitrogen. An additional 1,980 samples were analyzed in the shore laboratory for calcium, magnesium, sodium, potassium, sulphate, chloride, bicarbonate and 800 for cadmium, chromium, cobalt, copper, total iron, lead, lithium, manganese, molybdenum, nickel, vanadium and zinc by atomic absorption spectrophotometry using solvent extraction techniques. Approximately 300 samples collected from Lakes Erie, Ontario, Huron, Superior and St. Clair at selected locations were analyzed for mercury.

Bioassay Studies

Analytical support was provided to the Fisheries Research Board detachment at CCIW in its bioassay studies. A total of about 650 integrated water samples collected from Lakes Ontario, Erie and Huron were analyzed aboard ship and in the shore laboratory for soluble and total nutrients including total organic carbon, total alkalinity; 300 for major ions and 1,300 for trace elements.

Water Quality Network

The sampling and analysis programs for the Water Quality Network were continued on the Great Lakes. Water samples collected from designated stations were analyzed for soluble nutrients, total phosphate, total organic nitrogen, major ions and trace elements as part of the total lake monitoring program.

Georgian Bay Project

In collaboration with the Great Lakes Institute of the University of Toronto and Technical Operations Section of the CCIW Lakes Division, the C.C.G.S. PORTE DAUPHINE was equipped by the Water Quality Division detachment to undertake four monitor cruises on Georgian Bay. Operational and technical instructions, reagent supplies, sample bottles and other necessary equipment were provided by the detachment for the study, the purpose of which was to obtain base line water quality information on Georgian Bay. A total of approximately 380 water samples were analyzed aboard ship by the Great Lakes Institute personnel for dissolved oxygen, turbidity, pH and specific conductance. Also, about 380 water samples were collected and returned to the Water Quality Division detachment shore laboratory where they were analyzed for soluble nutrients; 760 were analyzed for total phosphate, total organic nitrogen and 300 for total alkalinity, major ions, total organic carbon and trace elements.

Thermal Bar Study

Analytical support was provided by this detachment to the Chemical Limnology Section of Lakes Division in its Thermal Bar Studies on Lake Ontario. A four-channel auto analyzer system was installed onboard the CSS LIMNOS and water samples were analyzed aboard ship and in the shore laboratory for total and soluble nutrients, major ions and trace elements.

Hypolimnion Study

The detachment also participated in and supported the one month Hypolimnion Study on Lake Erie which was co-ordinated by the Chemical Limnology Section. A six-channel auto analyzer system was installed on the LIMNOS and about 5,700 tests for orthophosphate, soluble reactive silica, nitrate, nitrite, ammonia, filtered and unfiltered alkalinity were completed by the Water Quality Division detachment personnel.

Rain Water Chemistry

The Chemical Limnology Section continued, throughout the year, to collect rain water samples which were analyzed by the Water Quality Division detachment laboratory. A total of approximately 130 such samples were analyzed for pH, total and soluble nutrients, total alkalinity, major ions, copper, lead, zinc, cadmium and total iron.

Interstitial Water Analysis

A number of interstitial water samples collected from lakes sediments by sections of the Lakes Division were analyzed by this detachment for major ions, total alkalinity

nd trace elements.

\ir Sudbury Project

As part of the studies on precipitation of pollutants and o determine the importance of atmospheric contributions o northern Ontario lakes, this detachment collaborated vith a number of agencies in the Air Sudbury program vhich commenced in June. Participants included the AcMaster University Department of Geology, the Ontario)epartment of Lands and Forests in Sudbury and the)ntario Water Resources Commission. A total of 50 rain amples collected in the Sudbury area were received and nalyzed in our shore laboratory for cadmium, chromium, obalt, copper, total iron, lead, manganese, molybdenum, ickel, vanadium and zinc.

Round Robin Series

As part of the Water Quality Division program to check nd maintain uniformity of methods and techniques in all of its laboratories across Canada, the CCIW detachment also articipated in this study, the purpose of which was to ompare performance and obtain data on precision in articipating laboratories.

Special Studies

(i) A number of samples were received and analyzed for certain constituents in support of the McMaster University study of emissivity of water surfaces.

(ii) Again this year, a special study was conducted on the Hamilton Bay water. Samples collected from strategic locations in the bay were analyzed for various constituents.

(iii) On five separate occasions, special investigations and trials were conducted on Lake Ontario and the Hamilton Bay with the Hydrolab and Plessey Submersible water quality monitor systems. The Plessey Submersible was moored at selected locations in the lake for the continuous recording of water quality data (pH, dissolved oxygen, specific conductance, turbidity, temperature, time and depth) (Figure 18). A total of approximately 600 water samples were analyzed with both instruments and the data compared with that obtained by the usual manual methods.

(iv) Special investigations were conducted to study what effect filtration of water samples may have on the actual sample composition.

Instruments and Methodology Development

(i) With the co-operation of the Engineering System Section of CCIW, the Hydrolab water quality analyzer and the Plessey Submersible water monitor systems were calibrated and standardized for use.

Figure 18. Plessey Submersible water quality monitoring system under test on Lake Ontario.

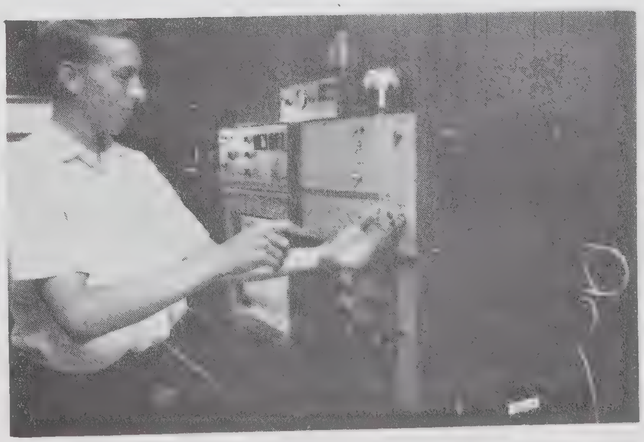


Figure 19. CHN Analyser for shore-lab determination of carbon, hydrogen and nitrogen in particulate samples.

(ii) A new model 403 Perkin-Elmer atomic absorption spectrophotometer was acquired and put into operation to alleviate the heavy workload demands previously on our single instrument.

(iii) A Hewlett-Packard CHN analyzer (Figure 19) and a Fisher-Hamilton gas partitioner were also obtained and calibrated for laboratory use.

WATER POLLUTION RESEARCH SUBDIVISION

The Water Pollution Research Subdivision of the Water Quality Division is primarily concerned with efficient and economical methods of pollution abatement and renovation of wastewaters arising from municipalities and industries across Canada. Besides undertaking a limited number of its own studies, the Subdivision has responsibilities to encourage, to co-ordinate, and to contract for both university and industrial research across Canada related to water and wastewater treatment. The headquarters of the Subdivision will be moved from Ottawa to CCIW upon completion of the Water Quality Pilot Plant in mid 1971.

During 1970 the activities of the CCIW Detachment of the Water Pollution Research Subdivision centred around the Water Quality Pilot Plant under construction, which will have modular treatment facilities for applied research on new and improved processes developed in the laboratories of the Centre and elsewhere. In late winter and early spring, meetings were held with the architects and engineers during the conceptual and final design stages. In June, The Grunwell Associations Limited submitted its preliminary report on the pilot plant facilities. The proposals contained in the report were subsequently reviewed by the Working Group on the Water Quality Pilot Plant, an advisory subcommittee of the ACCC composed of technical representatives from two provinces, universities, industries, consulting engineers, and federal departments. The Working Group was formed to advise on such aspects as equipping the pilot plant, research priorities, specific research proposals, and allocation of space and facilities. In August a contract was awarded to Bramalea Contracting (Peel) Limited, for completion of the Water Quality Pilot Plant by June 1971. In October, The Grunwell Associates Limited were retained to prepare plans and specifications for the pilot plant equipment to be purchased and installed up to December 1972. A number of meetings were subsequently held with the consultant regarding equipment purchases in the 1970-71 fiscal year.

Besides preparing for the Water Quality Pilot Plant, staff concentrated on current fundamental and engineering research on the removal of phosphorus and nitrogen from municipal wastewaters. Visits were made to the major advanced wastewater treatment plants operated by the FWQA in the eastern U.S.A. and southern California. The 5th International Association on Water Pollution Researc Conference and the Water Pollution Control Federatio Annual Meeting were attended for their programs in thi area of research. State of the art papers on both phosphoru and nitrogen removal are presently being prepared as conclusion to these investigations.

Similarly in the water treatment and water renovatio field the reverse osmosis process received considerabl study and evaluation. The American Water Works Ass ciation Annual Meeting was attended and potenti suppliers of reverse osmosis equipment in Canada wer contacted. Presently a research proposal is being prepare for a possible study on saline well-waters in the Prairi provinces.

During the year reviews and recommendations o research proposals by the private sector dealing with wat and wastewater treatment were made to the Nation Advisory Committee on Water Resources Research Secr tariat. Staff also served on the NACWRR Site Visiti Committee considering the University of British Columb Development Grant proposal to establish a Water Resourc Research Centre and acted as a liaison officer on a contra with the Canadian Canners Limited Research Centre Burlington, Ontario, for research on the movement pesticides and fertilizers resulting from the annu treatment of sweet cornfields.

In 1970 the Subdivision was directly concerned with number of other contracts and research projects involvi the university and private sectors. The Division contract with James F. MacLaren Limited, Consulting Engineers, f a report on "Removal of Iron, Manganese and Sulphi From Well-Waters for Rural Supplies". Through the Cen a contract was awarded to the University of Toronto f research on a partial nutrient removal system (phospho and nitrogen) to be conducted at the Town of Pe tanguishene activated sludge plant. Staff served as advis to Central Mortgage & Housing Corporation on its resea contracts with the Ontario Research Foundation on t process for wastewater treatment in an enclosed envir ment and Prosearch Limited on sewage treatment pl design. At the end of the year, the Division was invited the Town of Burlington to participate in a joint study to conducted at the Skyway Water Pollution Control Plant phosphate removal. This will be a co-operative resea project conducted by James F. MacLaren Limited, Con ting Engineers for the Town of Burlington with assista from Ontario Water Resources Commission and CCIW.

In addition to the programs already cited the S division staff at CCIW were active across Canada i number of areas. These included membership on the W

Treatment Task Force of the Okanagan Study Committee; the presentation of a paper on the "Aims and Programs of the CCIW" at the Calgary Annual Meeting of the Canadian Institute for Pollution Control; membership on the Treasury Board Utilities Processes Subcommittee on Sewage Treatment Plants in Ottawa; and visits to environmental engineering professors at the University of New Brunswick and Nova Scotia Technical College.

Resources Research Centre (Policy Research & Co-ordination Branch)

The year 1970 was the first year of full operation of this unit, the Lakes Management Section, Policy Research and Co-ordination Branch. The Section has responsibility for a social and economic research program into problems of lakes management and water use in the Great Lakes Basin. In addition, the unit performs a number of support functions to the CCIW.

The major focus of the Section's activities have been directed towards the development of an overall research strategy within which to analyze water use management problems and the undertaking of a number of initial research projects, on aspects of water use, improvement of the availability of water use data, public attitudes towards water use problems and institutions for lake management. A considerable proportion of the Section's activities have been conducted in support of other operations at the CCIW, both in research and administration.

The Section has assumed responsibility for secretarial duties for the Advisory Committee to the Canada Centre (ACCC) and its working groups. It provides also, liaison with the Great Lakes Basin Commission, the U.S. federal-state agency responsible for comprehensive planning in the Great Lakes Basin. The unit furnishes representation on a number of inter-departmental committees and task forces.

The major research projects undertaken during the year have centred around the wide economic implications of environmental quality management in relation to the use of the water resource for the disposal of wastes and public knowledge of and attitudes towards major water management problems. An attempt has been made and is continuing to upgrade the quality and availability of basic data on water use.

The investigation of the use of potentially environmentally harmful substances in the Great Lakes Basin has developed into a major research project and it is expected that the study will be extended to all Canada. Preliminary work was done during the year on a number of heavy metals, PCB's and the use of pesticides in agriculture. A number of draft reports have been prepared but data difficulties have hampered the production of definitive information.

During the summer of 1970 a survey was made of the extent of knowledge of the detergent phosphate problem among a sample of Hamilton housewives and of their attitude towards the regulation of the phosphate content of detergents. The analysis of the information is not complete but it appears that few housewives were well informed and that concern varies directly with social status.

A Water Use Map of the Great Lakes is nearing completion and all the essential information from both the United States and Canada has been collected. This project has largely been done for the Resources Research Unit by the Economic Geography Section, Policy Research & Co-ordination Branch. It is planned to publish the map in the spring, 1971.

A peripatetic program of restricted investigations into the changing pattern of economic and related urban development in the basin has formed a significant part of the Section's activities. Observed trends have been evaluated for impact on the water resources. The most significant projects in this area includes an investigation of municipal waste treatment cost variations, analysis of possible beneficial applications of waste heat and the effect on the water resource of alternative distributions of future population and economic activity.

Public Health Engineering Division (Dept. of National Health and Welfare)

GREAT LAKES STUDIES

Between May and November 1970, the Department of National Health & Welfare bacteriological personnel participated in eight monitor cruises on Lake Ontario, Lake Erie and Lake Huron. These cruises were part of a long-term monitoring program designed to determine the presence, concentration, extent and sources of bacteriological pollution within these lakes (coliforms and other indicator organisms). Determinations of the bacterial concentration, which is related to lake productivity were based upon the density and the biomass.

GREAT LAKES RESEARCH

Two major bacteriological studies within Lake Ontario and Lake Erie were completed during 1970-71. These were part of a continuing co-operative project undertaken jointly by scientists from the Department of National Health and Welfare and the Department of Energy, Mines and Resources. These studies were:

(a) Preliminary bacteriological investigation of the Lake Ontario thermal bar and its effect on confining effluents, waste discharges and nutrients originating from rivers, landwash and outfalls to the nearshore areas of Lake Ontario; and

(b) Microbiological studies of nutrient regeneration and oxygen depletion processes in the central basin of Lake Erie.

BACTERIOLOGICAL SEDIMENT ANALYSIS PROGRAM

During 1970 a detailed sediment sampling program was undertaken in the Kingston Basin and St. Lawrence River outlet of Lake Ontario in conjunction with the Limnogeology Section of the Canada Centre for Inland Waters. From this study bacterial density and biotype distribution patterns in the sediments were obtained. The effect of various local factors, such as sewage treatment plants, industries and farming areas on the density and biotype distribution patterns were investigated.

Environmental Quality Co-ordination Unit

The EQCU co-ordinates the results of research produced by the various disciplinary groups of the CCIW and prepares reports recommending policies on water quality and methods of controlling pollution. The Co-ordinator advises the Director of the Centre on pollution research and on development of programs in this field. He assists in providing liaison with provincial and federal abatement agencies and with our counterparts in the United States. Work continued on a Federal Contingency Plan and on the Interdepartmental Working Group on Pesticide Research in the Great Lakes. New projects included co-ordination of an evaluation of the impact of NTA on the environment, and chairmanship of the Scientific Advisory Committee of CCIW and of the Technical Working Group for the Federal Contingency Plan.

Work on the Federal Contingency Plan for combatting oil and other toxic material spills was greatly accelerated during the year due to the grounding of the tanker "Arrow" in Chedabucto Bay early in the year. Activity directly related to oil spill Contingency Plans accounted for a major portion of the activity within the Unit during the year. The Co-ordinator and F.M. Boyce of Physical Limnology Section assisted in the early days of the Arrow affair by supervising the testing of a burning technique for the removal of the oil and evaluating the use of straw as an oil absorbent. In June, the Co-ordinator flew to Fort Chipewyan on Lake Athabasca to observe the clean-up efforts there as a result of a spill of synthetic crude into the Athabasca River at Fort McMurray. In both instances the experience gained by on-site participation and observation was useful in producing the final versions of the Interim Federal Contingency Plan and the Field Manual being prepared for use by the On-Scene Co-ordinators under the Federal plan.

Early in 1970 the Co-ordinator was appointed Chairman of the Technical Working Group under the proposed Federal Contingency Plan. This Working Group was responsible for the production of a Field Manual containing

descriptions of clean-up methods for oil and toxic substances in various circumstances. Membership is drawn from all interested federal departments and private industry.

During the summer of 1970 the Interim Interdepartmental Committee on Contingency Planning was formed. This Committee, under the chairmanship of Captain William Stuart of DOT, produced the Interim Federal Contingency Plan which was officially promulgated in the fall. The Director of CCIW is named in the Plan as Regional Co-ordinator for the Great Lakes region and the EQCU has been active in support of the Director in developing the detailed planning for the Great Lakes region.

The Interdepartmental Working Group on Pesticide Research in the Great Lakes met twice during 1970 and continues to co-ordinate the development of research programs and proposals. The first research program developed by the Working Group was initiated during the year with the monitoring of pesticides in Lakes Erie and Ontario. The 1970 cruise program placed major emphasis on the establishment of proper sampling and analytical techniques with replications of water and biota samples at single stations. A small number of single sample stations throughout the lake gave preliminary estimates of the distribution of these pollutants. To date, only water samples have been analyzed and these were uniformly below the level of detectability. The second phase of this program will be carried out in 1971 cruises with emphasis on temporal and spatial variation of various pesticides throughout Lakes Erie and Ontario. Four new research proposals currently are under development by small task forces of the working group. These include the effect of pesticides on algal production, aerial transport of pesticides into the lakes, the interaction of pesticides with bottom sediments, and the sub-lethal effect of pesticides on aquatic biota.

The proposed substitution of NTA for phosphates in laundry detergents resulted in a massive research effort in Canada, U.S.A. and Sweden to evaluate the potential impact of NTA on the environment. The EQCU played an active role in the development of this program and in particular in co-ordination between research scientists and industrial representatives. Several meetings with representatives of the detergent industry and with the washing machine manufacturers' associations were held. Scientists from the United States and Sweden met with Canadian scientists at CCIW in December to exchange recent research data on this important subject. This led to recommendations against extensive use of NTA in detergents.

During the year the EQCU prepared papers on pesticide registration procedures and "A Canadian Environmental Council".

The Environmental Quality Co-ordination Unit assisted the Director of CCIW in co-ordinating the scientific program by providing the Chairman and Secretary for the Scientific Advisory Committee (SAC), which considered major problems of common interest on water resources management and recommended to the Management Committee scientific policies and programs to provide the information needed to solve these problems. SAC reviewed research programs of the various detachments and sections so as to achieve a full exchange of information and, where desirable, the co-ordination of effort. The Unit provided leadership in the development of a co-ordinated preliminary cruise report procedure and for a CCIW Task Force on Oil Pollution Research. In December it was decided the functions of SAC would be divided between subcommittees of the Management Committee and a new scientific council which will be representative of the body of professional staff at CCIW and deal with subjects of concern to those professionals such as seminars, library and publications.

The Co-ordinator represented CCIW on a number of interdepartmental committees and working group including the Interdepartmental Working Group on Water Quality Networks, the Advisory Committee to the Saint John River Basin Study, the Working Group on Nutrients, and Energy, Mines & Resources Departmental Committee on Oil Pollution. In addition, he serves on the Sub-Group on Contingency Plans of the U.S.–Canada Working Group on Great Lakes Pollution.

Liaison was maintained with several international associations by participating in a number of conferences and symposia including the American Water Resources Association, the Water Pollution Control Federation, and the Committee on Concerns of Modern Society of NATO in Brussels.

Engineering and Scientific Support Division

The Engineering and Scientific Support Division provides the major portion of the technical and professional support required for the scientific programs at the Centre. It consists of four sections and is concerned primarily with

providing the following:

(a) the development, design and production of prototype instrumentation for a specific scientific requirement,

(b) the research on methods of obtaining samples and monitoring physical, chemical, geological and biological variables, and the development of the resulting instrumentation,

(c) specialized scientific services required on an occasional basis by all research groups, or which by virtue of equipment costs or special operating and servicing requirements, are impractical to provide on an individual basis to research sections,

(d) research in new techniques for sample analysis or uses for the scientific equipment,

(e) suitable computer facilities on site or by rental agreements,

(f) the quality control and storing of original data and provision of programming expertise,

(g) reference library facilities to research groups at the Centre.

The activities of each section are discussed below.

ENGINEERING SYSTEMS

Generally, the Section provides engineering services to all divisions and agencies of CCIW, including the design, development, instrumentation and maintenance of limnological and water resources instrumentation systems and automatic data acquisition and processing systems. A description of some of the more interesting projects and activities in 1970 follows.

Fixed Temperature Profilers

These are data acquisition packages for obtaining time-series temperature profiles at various fixed locations in the lakes. The package itself is submersible or can be mounted on a surface buoy or platform. Twenty thermistors are attached to a cable which is connected to the profiler, thereby providing temperature information at 20 depths below the unit. The information is recorded as digital numbers on a magnetic tape recorder contained within the profiler package. The unit has sufficient power to measure and record these temperatures every 10 minutes for 8 weeks.

Triple Corer

In the course of geochemical investigations of silts and muds, a sampler was required that could operate to a depth of 400 metres and accurately core a sufficient quantity of material for a layer by layer analysis of the lake sediments. An instrument has been developed based on the standard Benthos corer, but consisting of a cluster of three coring tubes contained within a cylindrical support housing. Different lengths of coring tubes can be easily attached to the unit. Commercially available Benthos valves are used to retain the core samples but the valve release mechanism is an in-house design. A special screw-type core extruder has also been produced for use with the triple corer.

Meteorological Packages

Initially developed last year, the "met pack" systems are remote stations capable of recording meteorological data in situ on magnetic tape. In a continuing development program, these systems compared favourably with D.O.T. Met. Branch instruments. Comparison tests were also conducted between buoy-mounted packages and identical packages mounted on fixed towers. From the results of a successful 40-day trial, the design of the packages has been fixed, and procurement action for sufficient units to maintain 11 buoy-mounted packages on Lake Ontario during the International Field Year on the Great Lakes (1972) has been initiated.

Water Sampling System

Development began on a system designed to obtain samples from a water column to a depth of 30 metres. The equipment consists of a submersible pump, umbilical cable, surface handling equipment and a plumbing system. When used in conjunction with an electronic bathythermograph (see below) the system is capable of far greater resolution and accuracy in obtaining water samples than standard bottle casts, as shown by repeatability tests. To supplement standard chemical analysis techniques automatic water quality probes can be immersed in the sample hose outlet jet. Since the volume of water sample obtained is large compared to bottle casts, and since an analysis can be repeated if necessary, the confidence in data points is greatly increased.

E.B.T.

The Electronic Bathythermograph (E.B.T.) is a device for producing a vertical temperature profile of a column of water. This device was originally developed in-house, but modified in consultation with Dr. Dauphinee of NRC and Guildline Instruments Ltd., Smiths Falls, Ontario, who were awarded a contract to manufacture an initial quantity of three units. The accuracy of the sensor system is 0.02°C over a 30°C range and 0.1% of depth. However, the present readout system is an X-Y chart recorder which limits the readout accuracy to 0.1°C and 0.25% of depth range. We have two configurations, one for use from launches

employing a hand winch, which limits the depth to 100 metres; the other configuration is a permanent ships installation with power winch, permitting recordings to 400 metre depths.

Dye Diffusion System

Engineering assistance was provided to the Physical Limnology Section in support of their simulated outfall diffusion studies (OSEX). The system uses a fluorescent tracer dye (Rhodamine B) which is released from a controlled source, 20 metres deep. The resulting plume is traced and can be spot-sampled at depths to 50 metres or continuously sampled at any depth between 20 metres and 6 metres via a towed hose and pumping system, and between 6 metres and the surface with an immersed streamlined boom having 6 discrete sampling points. The dye injection system is on a moored pontoon boat having a 200 gal. dye tank, a 3.5 KW diesel generator and several pumping systems.

SCIENTIFIC SERVICES

Since this is a relatively new Section, in operation only three months, much time was spent on planning of the facilities and initiating procurement action for various items of scientific equipment.

Two new laboratories are in the process of becoming operational. The Radiochemistry Laboratory is being equipped for low-level β-ray counting and γ-ray spectrometry in order to study the distribution of radio-active nuclides in lake sediments as a first step in contributing to the present programs underway at CCIW. The Electron Microscopy Laboratory has recently received a Siemens high resolution transmission electron microscope which will be used in the study of sediments and biological specimens.

COMPUTER AND DATA SERVICES

The Computer and Data Services Section has the responsibility for planning and implementing data processing systems for CCIW. The Section has three main units: The Computer Applications unit which develops software systems and assists scientific staff in implementing their programs; the Computer Systems unit which schedules and operates the on-site hardware; and the Data Preparation, Storage and Retrieval Unit which processes and quality checks manually collected data.

The Section has two small computers; a PDP 8/S which is used primarily to translate instrumentation tapes to computer compatible magnetic tape, and a larger PDP-9 which is used for special applications. These applications include 3–D and contour plotting, analog to digital conversion, paper tape conversion, data quality control and experimental programming languages. A Control Data 200 User terminal, connected to a CDC 6400 at McMaster University, is leased and provides a very useful extension to our facilities. This year, in excess of 10,000 jobs were run through this terminal to McMaster, taking approximately 3360 min. of Central Processor time. A library of 250 reels of magnetic tape is maintained on which our original data are stored. A teletype timesharing service from COMSHARE was installed and is undergoing a feasibility study.

During 1970 data from 27 scientific cruises on the Great Lakes were processed. Computer generated reports and analyses were provided. Additional historical data on Lake Ontario current movements were obtained from U.S. Federal Water Quality Administration and added to CCIW's data base.

Some of the software developed for use at the Centre are,

- Geodyne current meter statistical analysis package,
- CZAR, a comprehensive time series storage and retrieval system,
- a report generating and quality control program for storage and retrieval of our monitor cruise (STAR) data,
- Quality Control programs for the shipboard data logger,
- an extensive program package for Project Hypolimnion.
- analysis programs for the Towed Thermistor chain,
- programs for analysis of data from the buoy-mounted meteorological packages.

Programs that have been implemented, but developed elsewhere, include

- 3-dimension and contouring routines,
- general purpose contouring package,
- cluster and factor analysis,
- non-linear least squares curve fitting program,

and those obtained by contract with McMaster University are a

- STAR storage and retrieval system, and
- STAR data editing and quality control.

LIBRARY

During 1970 the library continued to develop in support of CCIW's research program. Fifteen hundred books were added to the collection; subscriptions continued to 800 journals plus 170 data reports, abstracting

services and other similar items. The library obtained on inter-library loan over 1,000 items for scientific staff which were from a variety of older journals and their frequency of use does not justify our purchasing back volumes. Our usefulness to other libraries is also increasing; one hundred items from our collection were loaned to libraries from Newfoundland to Alberta. Our list of serial holdings will appear in the next edition of the Union List of Scientific Serials in Canadian Libraries, and at that time our collection should become even more useful to others.

Forty-two translations were made in 1970 for CCIW scientists by the Secretary of State's Translation Bureau. Information on these was given wide circulation resulting in frequent borrowing by scientists outside the Centre. Most of our other library facilities are also used extensively by students of local universities. Statistics kept in February 1970 indicated that an average of 60 persons per day used the library and the staff provided information in reply to an average of 22 questions per day.

Continuing library services include production anc distribution of *Collected Reprints* volume 2, to exchange libraries; distribution of a bibliography of CCIW's staf publications; assistance in producing IFYGL bibliography production of acquisitions lists; distribution of tables o contents of journals to staff members and production of a revised list of serial holdings. Three computer profiles are now operating in two different SDI programs. A program is being introduced to determine the length of time tha journals should be retained in the collection.

At one of our Library Committee Meetings informatior retrieval was discussed. At the present time appropriate abstracting and indexing services are provided for scientists or computer profiles are submitted for them. In the future more sophisticated information retrieval systems are planned.

Public Relations and Information Services

Mercury, phosphates, NTA and the Canada Water Act were among the words and phrases which grew in familiarity with the passing months of 1970. Pollution and water management gained new heights of popularity as subjects for speakers, for feature articles and for special broadcasting programs. In step with this interest and the increasing demand for stories and news of the research work of the Canada Centre for Inland Waters, the Public Relations Unit spent a busy but rewarding year.

Feature coverage was given the Centre by some of the country's largest daily papers. In television, the Centre graduated to network status as cameras from both Canada's national systems focussed on its work for feature programs. Company and corporate magazines also found the CCIW worthy of articles and special stories.

Increasingly, too, the Centre's staff met the public, often in person through public speaking engagements, or through the broadcast interview. The "open line" radio program also recognized the importance of the Centre's work when on two occasions, the Director of CCIW occupied the guest's chair to discuss on the air the problems of modern water management and the role of scientific research in solving them.

Perhaps the Centre's most unusual source of publicity during the year though, was a tractor-towed float in an inter-provincial service club parade which proclaimed that the branch represented by the vehicle's riders came from "Burlington – Home of the Canada Centre for Inlanc Waters"!

Many events provided good opportunities to explain the Centre's work to an increasingly interested public. Among these were Burlington's "Let's Control Pollution Week" the International Association for Great Lakes Researcl annual conference in Buffalo; "Operation OSEX" (Outfal Simulation Experiment) at Oshawa; the unfurling of the Centre's new logogram flag; "Project Hypolimnion"; the visit of the U.S. National Academy of Science; "Projec Tomato"; Hamilton's "Survival Week"; and the officia opening by the Minister of Energy, Mines and Resources o the CCIW Research and Development Building.

Audiences in service clubs, civic action groups, churcl groups, associations and other organizations addressed or the work of the Centre during 1970, numbered more thar 2,000. The Public Relation Unit's school speaking progran was accelerated to reach a total audience of more thar 15,000 – a ten-fold increase over 1969.

As the year closed, preparations were in hand fo construction of a major exhibit to be housed in the Centre' new Main Laboratory Building. Work on a library of colou transparencies was well advanced and a photo library was ir the planning stages. Also planned was a film on the CCIV for presentation to audiences in the Centre's theatre. A nev slide show on the Centre, titled "Everybody's War" hac also been produced by the Unit and was virtually complet at year's end.

Administration and Building Program

ADMINISTRATIVE SUPPORT

1970 brought an increase in the number and range of activities requiring central administrative support. Acceptance of the first set of new buildings involved phasing in a new telephone system; designing and encouraging the use of a centralized stores system; a major purchase of new office furnishings; planning and implementing the move into the new quarters and modifying the central registry service to meet the needs of both the increase in staff and the problems of the physical growth on the site.

The maintenance of equipment, buildings and grounds has become an increasingly complex function. Along with the growth in staff, facilities and programs, a site and field safety program has been organized and implemented. Initial development of a centralized purchasing service was begun in 1970 and it is expected that this will develop further in 1971.

In support of contract work performed by the private sector and the university community, the administrative support group was active in the development of contract formats and the general policy considerations attached to contract work.

BUILDING PROGRAM

1970 has been an important year in the construction program for the permanent buildings of the Canada Centre for Inland Waters. Three major buildings have been under simultaneous construction. The three separate contracts for these buildings were won by the Bramalea General Contracting (Peel) Ltd., at a total dollar value of $13,195,600.

On July 3, 1970 the warehouse and workshop elements of the first building contract were completed and personnel moved from the temporary quarters into these new facilities. The balance of buildings under this contract, the Research and Development building and the heating and cooling plant, were accepted on November 4, 1970 and were occupied immediately by additional personnel from the trailer complex. With the completion of this portion of the building program, the Centre's personnel now occupy nearly 160,000 square feet of permanent building area which was completed within budget and within 16 days of the targeted completion date.

The Centre's main laboratory and administration building was contracted on March 5, 1970. The scheduled completion date for the contract is March 31, 1972. The construction of this 8 million dollar building is, at present, two months behind schedule. However, completion on target is expected.

The Water Quality Pilot Plant contract was awarded on August 14, 1970 and completion is called for by June 14, 1971. The tenders for this building were first closed in April, 1970. However, the lowest tender was 26% over the budget estimate. Redesign was undertaken and the building was re-tendered. The contract now in hand is within our program budget. Construction work on the building is progressing well and completion on time is expected.

The Hydraulics Laboratory is the last building to be constructed under the program. Design of the building has now been completed and it is planned that construction will commence in April 1971 and be completed by December 1972.

CCIW Staff List

CCIW

Director, CCIW – J.P. Bruce

Secretary – Mrs. L. Ward-Whate

Executive Assistant to Director – T.S. Hillis

Building Services Superintendent – D.F. Stewart

Support Staff, CCIW – C.F. Hicks, A.W. Mayes, D. Niles, J. Slaz, Mrs. B.D. Titley, Mrs. E. Vos

Personnel Administration, CCIW – Miss R. Kelly, Mrs. M. Duggan, Mrs. C. Shepherd, Miss M.R.J. Warren

LAKES DIVISION (Inland Waters Branch)

Chief, Lakes Division – Dr. R.A. Vollenweider

Secretary – Mrs. S.M. Horne

Chemical Limnology Section

Head, Dr. Mary E. Thompson – specification electrodes; low temperature aqueous geochemistry

Secretary – Mrs. R.E. Morrison

Dr. N.M. Burns – physical chemistry of water; carbon cycle in lakes

Dr. Y.K. Chau – trace elements in the lake environment

Dr. A. Lerman – geochemistry of brines; radioisotopes in lake sediments

Dr. R.F. Platford – physical chemistry of aqueous solutes

Dr. W.M.J. Strachan – organic chemistry

Dr. R.R. Weiler – surface chemistry of sediments

Postdoctoral Fellow –

Dr. C.W. Childs – physical chemistry of aqueous solutes

Dr. J.O. Nriagu – economic geochemistry, authigenic minerals

Chemists –

M.E. Fox – soluble organic compounds in large lakes

H. Saitoh – trace elements

M.T. Shiomi – atmospheric precipitation chemistry; nutrient cycles in large lakes

Technical Staff – R.D. Coker, K.W. Kuntz

Biological (Fisheries Research Board)

A/Head, Dr. A. Nauwerck – zooplankton and phytoplankton taxonomy; zooplankton-phytoplankton relationships

Secretary – Miss L. Sully

Dr. W.A. Glooschenko – algal pigments and degradation products; effect of toxic substances on algae

Dr. M. Munawar (Post Doctoral Fellow) – phytoplankton species distribution

C.F. Carpenter – zooplankton biomass studies

J.E. Moore – primary productivity measurements; nutrient enrichment studies

H.F. Nicholson – fluormetric surface chlorophyll distribution

H. Shrivastava – bottom fauna

Technical Staff – R.H. Collins, H.H. Dobson (seconded from Environmental Quality Co-ordination Unit), J.K. Leslie

Senior Scientific staff of Freshwater Institute, Fisheries Research Board, Winnipeg, working on Great Lakes Problems: Dr. A.L. Hamilton, Dr. K. Patalas.

Physical Limnology Section

Head Dr. R.K. Lane – administration, remote sensing

Secretary – Miss C. Pinkerton

Dr. C.R. Murthy – diffusion, circulation

Mr. F.C. Elder – air-lake interaction, thermal effluents

Mr. F.M. Boyce – internal waves, heat content, oil slicks

Dr. J.O. Blanton – thermal structure, demonstration basin studies

Mr. P.F. Hamblin (educational leave) – circulation, seiches

Mr. D.G. Robertson – descriptive limnology, climatology

Mr. H.W. MacPhail – electronics

Mr. B. Kenney – diffusion thermal effluents, small-lakes

Dr. T.J. Simons – hydrodynamics, modeling

Dr. K. Thomson – remote sensing

Dr. E. Nagy – oil/water studies

Dr. H. Weiler (until 27 July 70) – circulation studies

Support Staff – D. Beesley, Miss J. Bond, R. Chapil, F. Chiocchio, Mrs. P. Greenway, Mrs. D. Jordan, W.D. McColl, K.C. Miners, W.J. Moody, H. Ng, H.K. Nicholson

Limnogeology Section

Head, Dr. P.G. Sly – distribution and variance of lake bottom sediments

Secretary – Miss J. Brouwers

Dr. C. Jonys – quantitative assessment of bedload transport and geohydraulic processes

Dr. A.L.W. Kemp – distribution and diagenesis of organic compounds in recent sediments

Dr. C.F.M. Lewis (GSC) – post-glacial uplift and stratigraphic correlation of recent sediments

Dr. N.A. Rukavina – interpretation of sediment distributions in the nearshore zone

Dr. R.L. Thomas – distribution, occurrence and authogenesis of minerals, major elements and trace metals in recent sediments

Dr. J.D.H. Williams – sediment/water interface exchange, with particular emphasis on the phosphate and iron cycles

J.P. Coakley – distribution, occurrence and relation to erosion, transportation and deposition of active sediments

C.G. Gray (educational leave) – diagenesis of recent organic compounds

W. Warwick (educational leave) – paleo-ecological interpretation of chironomid faunas

Technical Staff – W. Booth, G. Duncan (A/Chief Technician), Mrs. M. Hicks, Miss L. Homer, Mrs. L. Mansey, T. Morton, Mrs. A. Mudrochova, R. Sandilands, D. St. Jacques

Technical Operations Section

Head, H.B. Macdonald

Secretary – Miss L. Magnussen

Senior Assistant – D.J. Cooper

Diving Officer – J.T. Roe

Standards & Development – D.J. Williams

Special Projects – P.R. Youakim

Operations Officers – D.H. Hanington, D.J. Brooks

Technical Staff: L. Benner, T.J. Carew, H.K. Cho, F.J. deVree, H.F. Don, P.M. Healey, R.D. Hore, G. Koteles, M.R. Mawhinney, B.H. Moore, P. Seidenberg, S.J. Statham, M.R. Thompson, S.P. Withers

International Field Year for Great Lakes

Canadian Co-ordinator – J. MacDowall

Administration Section

Head, H. Lawson

Support Staff – J.L. Harris, D.G. Jefferson, Miss I. O'Connor, Mrs. E. Rae

CENTRAL REGION (Marine Sciences Branch)

A/Chief, Central Region – T.D.W. McCulloch

Secretary – Miss L. Ram

Regional Hydrographer – T.D.W. McCulloch
Asst. Regional Hydrographer – R.W. Sandilands

Hydrography

Asst. Regional Hydrographer – R.W. Sandilands

Hydrographers-in-Charge	Field Party – Survey Area
R. Courtnage	Rideau River & Thousand Islands
G. Goldsteen	C.C.I.W. Ground Control
C. Leadman	Lake-of-the-Woods
R. Marshall	Technical Records
J. O'Shea	Polar Continental Shelf Project
A. Rogers	Lake of two Mountains
E. Thompson	Navigational Ranges
G. Wade	Revisory Survey
B. Wright	Lower St. Lawrence River
F.L. DeGrasse	Navigational Systems

Hydrographic Staff

K. Barnes, R. Beri, R. Chapeskie, J.V. Crowley, M. Crutchlow, K. Daechsel, P. Dal Bianco, P. Davies, B. Eidsforth, J. Gervais, M. Grant, S. Greenner, K. Hipkin, J. Kean, R. Langford, R. Lasnier, G. Macdonald, R. Mahaffy, J. McCarthy, R. Moulton, D. Nesbitt, P. Pagé, D. Philpotts, H. Pulkinnen, R. Rehbein, P. Richards, R. Robitaille, W. Silvey, R. Treciokas, E. Waugh, J. Weller, A. Welmers, J. Wilson

Ships & Launches

Head – A. Quirk
Support Staff – Capt. D.R. Young, master of CSS LIMNOS; K.D. Robertson – Foreman (120 seasonal employees)

Development Group

Head – E. Brown
Technical Staff – E. Lewis, R. Tripe, N. Stuifbergen.

Electronics Section

Head – V.S. Bains

Technical Staff – D. Chambers, R. Desilets, J. Lanouette, M. Moore, A. Prud'Homme, D. Pyatt, W.W. Smith, B. Waldock

Administration Section

Admin. Officer – A.W. Appleby

Support Staff – Mrs. B. Dal Bianco, J. Dobson, Mrs. E. Gervais, E. Gibbons, Mrs. F. Haaka, Mrs. F. Hannay, Mrs. L. Mortimer, J. Rothwell, J.E. Parsons, Mrs. P. Taylor.

HYDRAULICS SUBDIVISION (Hydrologic Sciences Division, Inland Waters Branch)

Head, Dr. T.M. Dick Dr. L. Lau

Secretary – Mrs. L. Kay

WATER QUALITY DIVISION (Inland Waters Branch)

Analytical Chemistry Laboratories

Head, Dr. V.K. Chawla
Chemist, F.J. Philbert

Scientific and Technical Staff – H. Alkema, W.D. Blythe, O. El Kei, S. Meszaros, Y.M. Sheikh

Water Pollution Research Subdivision

Head, A.R. Townshend

Secretary – Miss V. Knox

Dr. B.P. LeClair, A.D. Stephenson

RESOURCES RESEARCH CENTRE (Policy Research & Coordination Branch)

Head, Dr. T.R. Lee

Secretary – Mrs. R. Riggs

G. Bangay, Miss M.R. Sinclair, J.N. Thomson

PUBLIC HEALTH ENGINEERING DIVISION (NH&W)

Liaison Officers – Dr. C.P. Fisher, Ottawa; B.J. Dutka, Kingston.

Support Staff – P. Collins, A. Jurkovic, A. Menon, H. van Otterloo

ENVIRONMENTAL QUALITY CO-ORDINATION UNIT

Head, Dr. A.R. LeFeuvre

Secretary – Mrs. H. Hetherington

ENGINEERING & SCIENTIFIC SUPPORT DIVISION

Chief, A.S. Atkinson

Secretary – Mrs. D. Magee

Engineering Systems Section

Head, G.A. Jones

Electronics Unit Head – A.S. Eatock

Electronics Engineers – K.N. Birch (Educational Leave), K.R. Peal, J. Valdmanis

Technologists – J.A. Diaz, D. Fekyt, J.G.M. Laroque, K. Mollon, M. Pedrosa, A. Tyler

Mechanical Unit Head – A.E. Pashley

Mechanical Engineers – B.P. Brady, P.M. Ward-Whate

Technologists – R. Boucher, J.D. Heidt, H.A. Savile

Machinists – R.V. Chumley, K. Kalter, D.H. Whyte

Drafting Office – W. Finn, A.P. Gris, Miss S. Longstaffe

Computer & Data Services Section

Head, D.M. Francis

Computer Applications Unit – H.S. Weiler, O.I.C.

Programmers – B. Hanson, Miss B. Pyde

Computer Systems Unit – C. Pulley, O.I.C.

Support Staff – Mrs. M. Kinder, Mrs. P.A. Moody

Data Unit – W. Nagel, O.I.C.

Support Staff – J. Byron, K. Schopf, G. Smith

Library

Librarian, Mrs. E.A.C. Fosdick

Support Staff – Miss A.E. Boerchers, Mrs. C.E. Davidson

Radiochemistry Laboratory

Dr. R.W. Durham (A.E.C.L.)

PUBLIC RELATIONS & INFORMATION SERVICES

Head, A.R. Kirby

Secretary – Mrs. R. Mikoda

Appendix B

Publications and Presentations

PUBLISHED PAPERS

Blanton, J.O., and C.D. Jennings. 1970. Determination of fresh-water discharge for an Oregon estuary. Northwest Science, 44(3): 170-175, 1970.

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Prince, A.T. and *J.P. Bruce.* 1970. The Canada Centre for Inland Waters, An Approach to Research Co-ordination. Paper prepared for an OECD meeting, Hamilton, July 1970.

Allen, H.E., G.W. Baulne, *N.M. Burns*, J.R. Kramer. 1970

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Chawla, V.K. 1970. Changes in Water Chemistry of Lakes Erie and Ontario. Symposium at State University College in Buffalo, November 1970.

Coakley, J.P. 1970. Natural and artificial tracer studies in Lake Ontario. Proc. 13th Conference on Great Lakes Research, International Association for Great Lakes Research (in press).

Elder, F.C. and P.J. Denison. 1970. Thermal inputs to the Great Lakes, 1968-2000. Presented at the American Chemical Society, 160th National Meeting, Water, Air & Waste Chemistry Section, September 18, 1970.

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Gray, C.B. and *A.L.W. Kemp.* 1970. A quantitative method for the determination of chlorin pigments in Great Lakes sediments. Proc. 13th Conference Great Lakes Research, International Association for Great Lakes Research. (in press).

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Nauwerck, A. 1970. Zooplankton and the eutrophication of lakes. Presented at the Annual Meeting of the

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Platford, R.F. and *C.W. Childs.* 1970. Free energies of mixed salt solutions from 0 – 15°. Presented at the American Chemical Society 160th National Meeting, H.S. Harned Memorial Symposium, September 13-16, 1970.

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Sly, P.G. 1970. The responsibility of government, industry and university in marine science. Presented at the Central Canada University Geological Congress, Kingston, October 1970 (in press).

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Cronan, D.S. and *R.L. Thomas.* 1970. Ferromanganese oxides in Lake Ontario. Proc. 13th Conference Great Lakes Research, International Association for Great Lakes Research, (in press).

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Townshend, A.R. 1970. The aims and progress of the CCIW. Presentation to Canadian Institute for Pollution Control, Calgary, October 18-21, 1970.

Townshend, A.R. 1970. Water pollution and the federal government. Presentation to Water Reclamation Seminar, University of Waterloo, August 6-7, 1970.

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Names of CCIW authors are shown in italics.

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No. 3, 1968, Lake Ontario, Cruise 68-019, October 5-9; Cruise 68-022, October 27-31; Cruise 68-023, November 17-22.

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Canada Centre for Inland Waters, COLLECTED REPRINTS, Vol. 2 for inter-Library exchange program.

Appendix C

Staff Participation in Committees and Associations

Advisory Board to State University of New York's Sea Grant Programs (Lake Ontario) – J.P. Bruce

American Meteorological Society, Committee on Water Resources – Dr. R.K. Lane

American Water Resources Association, Board of Directors – J.P. Bruce

Canadian Aeronautics and Space Institute, Founder member of the Hydronautics Section – J. MacDowall

Committee on Water Resource Applications, Program Planning Office for Interdepartmental Committee on Resources Satellites and Airborne Remote Sensing – Dr. R.K. Lane

Great Lakes Working Group, Canadian Committee on Oceanography – Dr. R.A. Vollenweider

Instrumentation Advisory Committee, Mohawk College – G.A. Jones

Interdepartmental Committee on Nutrients – Dr. A.R. LeFeuvre, Dr. T.R. Lee

Interdepartmental Working Group on Contingency Plans – Dr. A.R. LeFeuvre

Interdepartmental Technical Working Group on Contingency Plans – Ch., Dr. A.R. LeFeuvre

International Association for Great Lakes Research (IAGLR).

President – J.P. Bruce

Editorial Board, Proceedings of IAGLR Conferences – Dr. R.K. Lane, Dr. P.G. Sly

14th Conference: Co-Chairman Program Committee – F.C. Elder; Co-Chairman Local Arrangements – G.A. Jones; Co-Chairman Public Relations Sub-Committee – A.R. Kirby

International Field Year for the Great Lakes, Canadian Co-ordinator – J. MacDowall.

Steering Committee – J.P. Bruce

Chemical & Biological Programs – Dr. R.A. Vollenweider

Energy Budget – Dr. R.K. Lane, F.M. Boyce

Lake Meteorology – F.C. Elder

Terrestrial Water Balance – Dr. R.K. Lane

Water Movement – Dr. H.S. Weiler

24th International Geological Congress – 1972, Montreal – Excursion Planning – Dr. P.G. Sly, Dr. C.F.M. Lewis

International Great Lakes Study Group – Dr. R.A. Vollenweider

National Research Council Associate Committee on Avionics – J. MacDowall

National Research Council, Committee on Environmental Criteria, Sub-committee on Water Quality Criteria – Dr. R.A. Vollenweider

National Research Council Sub-committee on Hydrology – Dr. R.K. Lane

North American Working Group on Manganese – Dr. R.L. Thomas

Organization for Economic Co-operation & Development – Working Group on Eutrophication, Water Management Research Group – J.P. Bruce, R.A. Vollenweider

U.S. – Canada Working Group on Great Lakes Pollution

Sub-Group on Water Quality Criteria & Programs – Dr. R.A. Vollenweider

Sub-Group on Contingency Plans – Dr. A.R. LeFeuvre

Sub-Group on Research Co-ordination – Co-Chairman – J.P. Bruce

Sub-Group on Co-ordination of Action to Meet Special Situations – Dr. T.R. Lee

World Meteorological Organization – Working Group on Hydrological Applications of World Weather Watch – J.P. Bruce

Appendix D

Advisory Committee to the Canada Centre for Inland Waters, and Working Groups

NATIONAL ADVISORY COMMITTEE ON WATER RESOURCES RESEARCH

ADVISORY COMMITTEE ON THE CANADA CENTRE FOR INLAND WATERS

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Dept. of Energy, Mines & Resources,
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Dr. H.F. Fletcher,
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Policy, Research and Co-ordination Branch,
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ACCC WORKING GROUP ON THE USE OF CCIW FACILITIES BY THE UNIVERSITIES

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J.P. Bruce
J.R. Kramer
A.D. Misener

ACCC WORKING GROUP ON THE SUPPORT OF RESEARCH IN THE PRIVATE SECTOR

J.W. MacLaren, Chairman
T.S. Hillis, Secretary
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ACCC INTERIM WORKING GROUP ON THE WATER QUALITY PILOT PLANT

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Dr. C.P. Fisher,
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Public Health Engineering Division,
Department of National Health and Welfare,
Tunney's Pasture,
Ottawa, Ontario.

Appendix E

Contracts 1970

1. Research study on a process modification for partial nitrogen and phosphorus removal to be carried out at an activated sludge plant at Penetanguishene, Ontario. (University of Toronto – $18,400).

2. Study to describe the nature and extent of chemical-physical-biological changes which occur in the lower Grand River and estuarial waters and their modification of eutrophifying effects of the discharge on Lake Erie. (University of Guelph – $14,400).

3. Carry out the analysis of error significance in energy flux computations from meteorological measurements over water. (Dr. R.G. Stevens, Dartmouth, N.S. – $6,100).

4. The development of a rapid analytical method for identifying mercury forms based on the differential release of mercury from its associated components in identifiable form at discrete temperatures and the volatilized mercury analyzed by a patented mercury spectrometer. (Barringer Research Ltd., $16,700).

5. Extension of a contract to continue research on a project involving the geological studies of the nearshore zone of Lake Superior from Wawa, north along the coast to the position approximately opposite Slate Island. (Lakehead University – $14,000).

6. Final pre-publication editing and quality review of all limnological data collected by the Great Lakes Institute, University of Toronto, during 1964. (Great Lakes Institute, University of Toronto – $3,800).

7. Contract to specify and advise on an oil spill research program and to assist in the preparation of a field manual on oil spill countermeasures (A.P. Frame Limited – $5,000).

8. Continuation of studies on the coastal jet phenomenon in an area to the west of Lake Ontario, off Oshawa. (University of Waterloo – $35,000).

9. Carry out a preliminary program of short-term measurements of aspects of solar radiation. (McMaster University – $5,000).

10. To provide limnological data from six monitor cruises on Lakes Huron, Superior and Georgian Bay. (Great Lakes Institute, University of Toronto – $25,000).

11. Preparation of scientific reports on the physical and chemical aspects of the environment of Lake Ontario and Lake Superior. (Great Lakes Institute, University of Toronto – $27,000).

12. Undertake a joint experiment with the Centre in connection with measurements and analyses of micro-scale thermal structure in Lake Ontario. (University of British Columbia – $1,000).

13. Development of a realistic mathematical model of the winter circulation of Lake Ontario. (University of Connecticut – $10,000).

14. Contract for design of data collection systems, the development and operation of programs for analysis of data from intensive area studies, and the preparation of historical summaries of chemical monitor cruise data for the Great Lakes (McMaster University – $32,100).

15. Special investigation, modification and study of recording water current meters (Canadian General Electric Co. Ltd. – $15,000).

16. Digitization of all bathythermograph traces taken on all of the synoptic surveys of the Great Lakes Institute on Lakes Huron and Superior and Georgian Bay from 1960 to 1970 inclusive. (University of Toronto – $3,500).

17. Documentation, processing and interpretation of previously collected limnological data consisting of spatial and temporal distributions of temperature in the Great Lakes. (University of Waterloo – $14,100).

18. Repair, maintenance and servicing of Plessey and Geodyne water current meters. (Canadian General Electric Ltd., – $44,600).

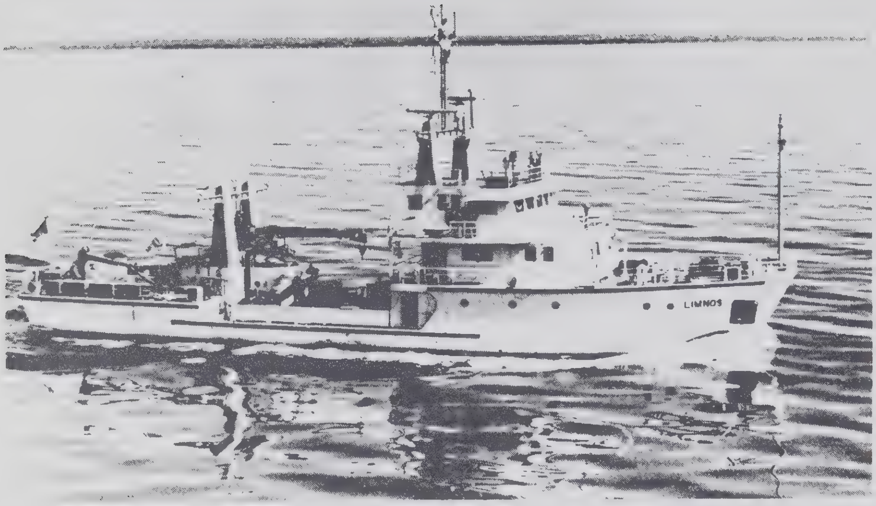
Environment Canada

Environnement Canada

CANADA CENTRE FOR INLAND WATERS

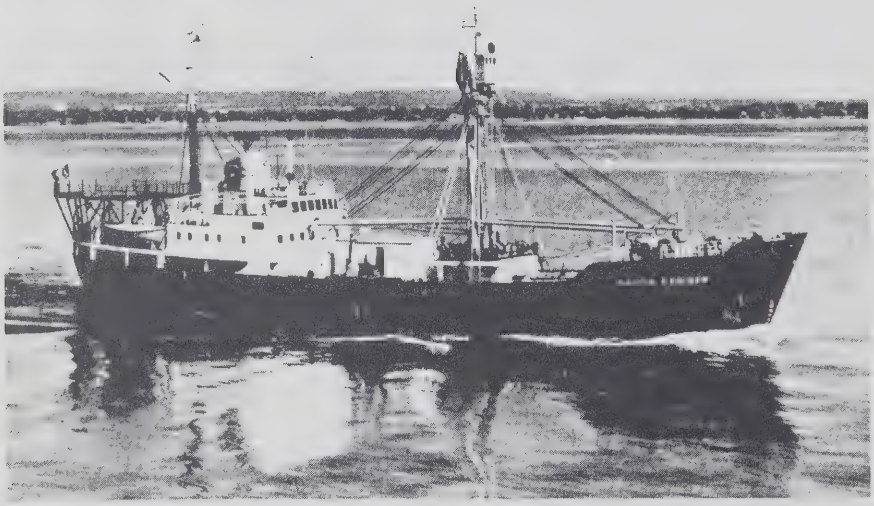
1971

CANADA CENTRE FOR INLAND WATERS – 1971



C.S.S. LIMNOS

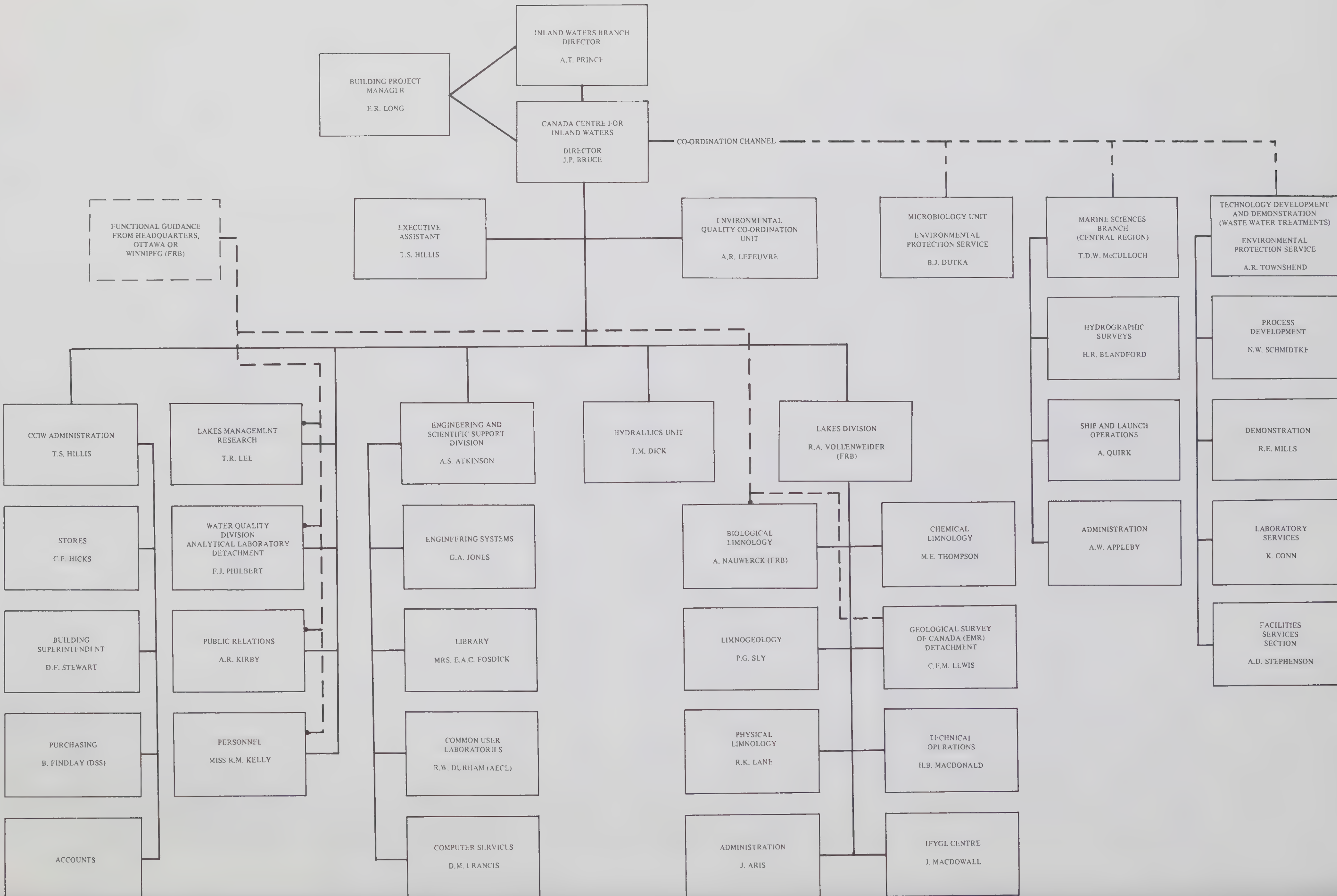
M.V. MARTIN KARLSEN



Canada Centre for Inland Waters - 1971

CANADA CENTRE FOR INLAND WATERS
DEPARTMENT OF THE ENVIRONMENT
BURLINGTON, ONTARIO, MAY 1972

Contents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BUILDING PROJECT MANAGER
E.R. LONG
CANADA CENTRE FOR INLAND WATERS
DIRECTOR J.P. BRUCE
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EXECUTIVE ASSISTANT
T.S. HILLIS
ENVIRONMENTAL QUALITY CO-ORDINATION UNIT
A.R. LEFEUVRE
MICROBIOLOGY UNIT
ENVIRONMENTAL PROTECTION SERVICE
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H.R. BLANDFORD
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ENVIRONMENTAL PROTECTION SERVICE
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PROCESS DEVELOPMENT
N.W. SCHMIDTKE
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C.F.M. LEWIS
TECHNICAL OPERATIONS
H.B. MACDONALD
IFYGL CENTRE
J. MACDOWALL

ighlights 1971

artment of the Environment

Transfer was made of nearly all components of the ada Centre for Inland Waters to the Department of the ironment, which was established officially on June 11, '1. Formerly, the Centre consisted of components of e federal departments. But now the program is conted by a federation of components and detachments n three major Services of the new Department: the er Management Service, Environmental Protection Ser-, and Fisheries Service. Responsibility for building elopment and management, central support services, and gram coordination rests with Inland Waters Branch of er Management Service. A major organizational change the Centre occurred with transfer to Environmental tection Service from Inland Waters Branch of responlity for applied technological aspects of wastewater tment research in the Water Quality Pilot Plant.

at Lakes Pollution Control

CCIW staff members participated actively in joint ada-U.S.A. working groups which prepared reports on ous types of control programs needed for the Great es, particularly Lake Erie and Lake Ontario. These king groups were asked to submit proposals for ernment response to the report of the International nt Commission on pollution of the Lower Lakes, issued 1970. This work lead to a Ministerial level meeting in shington in June 1971 at which the principles were pted allowing Canada and U.S.A. to enter into a formal ernational agreement on Great Lakes pollution control. sequently a 6-man negotiating team, on each side, was ointed to develop specific control programs and word- of the agreement. J.P. Bruce, Director of CCIW, is a adian Member supported by J.W. Schmidt of the ironmental Quality Coordination Unit. In anticipation signing of the international agreement a Canada-Ontario eement was signed in August to provide a speed-up in ds for municipal waste treatment, including nutrient oval, for Lakes Erie and Ontario. The agreement also orporated a special $6 million fund for waste-treatment earch and treatability studies to ensure that the nutrient oval program is conducted efficiently and effectively. A.T. Prince, Director of Inland Water Branch, is irman of the Review Board for the federal-provincial eement. J.P. Bruce and A.R. Townshend of CCIW are mbers of the Review Board's Technical Committee and . Shannon serves as Secretary of the Technical Comtee.

at Lakes Contingency Plan

The draft for an international contingency plan for oil and toxic materials spills for the Great Lakes was adopted for immediate implementation at the Ministerial meeting in Washington in June. The plan names CCIW as the coordinating centre on the Canadian side. The plan was invoked by Canada for the first time in late August, and dealt successfully with the situation arising from the collision of two tankers in the St. Clair River near Sarnia. It is estimated that only 12 of a potential 100 tons of oil were allowed to escape to the river, and thus damage to shore properties and marshes along the river and in Lake St. Clair was minimized. The event provided experience in operational procedures and communications and a guide for future action.

Project Hypolimnion

This multi-disciplinary project conducted jointly with Environmental Protection Agency, Cleveland, was led by Dr. N.M. Burns, Chemical Limnology Section, Lakes Division, and involved many CCIW staff members. It was designed to learn about the extent, causes, and consequences of oxygen depletion in the bottom waters of Lake Erie's central Basin. The field program was carried out in 1970. Full reports on the work were completed in 1971, presented at several conferences, and are in press. Findings on the extent and effects of oxygen depletion, and its direct relationship to phosphate loading, have lent great impetus to phosphate control programs for Lake Erie, both through the Canada-Ontario agreement and the current negotiations with the U.S.A. for pollution control programs. The U.S.A. Congressional Committee on Conservation has considered this a vital study in its deliberations on eutrophication control and is incorporating the findings in its report.

Building Construction

The Water Quality Pilot Plant was completed and occupied in the spring, and practically equipped by the end of the year. The 7-storey Main Laboratory Building is nearly completed and will be occupied early in 1972. The Hydraulics Laboratory is scheduled for occupancy in mid-summer of 1972, thus completing the CCIW construction program. This major construction project, coordinated by E.R. Long, Water Management Service and the Department of Public Works, continues within scheduled completion dates and budget.

Hydrographic Surveys

The far-flung nautical charting activities of the Central Region, Canadian Hydrographic Service, Marine Sciences Branch, continued during 1971, with major field programs in the Beaufort Sea, Ottawa River, Georgian Bay and Lake

Huron, Lake of the Woods, St. Lawrence River, and Playgreen Lake, Manitoba. Central-Region staff also assumed responsibility, as part of its revisory survey program, for keeping up-to-date the shoreline land use and erosion surveys initiated by Department of Public Works for the International Joint Commission studies of the Great Lakes levels controls. These latter surveys and the shoreline charts are proving to be valuable to Ontario Conservation Authorities bordering Lake Ontario, many of which have shoreline land use studies underway.

A chart sales outlet and Marine Information Centre were established at CCIW by the Marine Sciences Branch.

Phosphate Replacement Evaluations

With continued emphasis on control of phosphate content in detergents in order to reduce eutrophication, evaluation of potential environmental impact of possible phosphate substitutes continued, in coordination with Department of National Health and Welfare's studies of potential health effects. Nitrilotriacetic acid (NTA) and citric acid were investigated in this connection and the results of studies co-ordinated by CCIW. The current NTA evaluation program with reports scheduled for spring 1972, includes: (1) a coast to coast monitoring program of present NTA levels in various water environments by a number of components of Environment Canada to permit prediction of future concentrations; (2) evaluation by Environmental Protection Service (EPS) detachment, CCIW and Hydrologic Sciences Division, Ottawa, of potential effects of NTA on nutrient removal at wastewater treatment facilities; (3) bacteriological degradation of NTA (at CCIW) and (4) detergent cleaning ability as related to detergent formulation and water hardness (by contract with Ontario Research Foundation).

Transfer of Microbiology Section

The Microbiology Section based at Kingston, and formerly with Public Health Engineering, Department of National Health and Welfare, transferred to temporary quarters at CCIW in spring 1971. An active research program has been developed to complement the survey program of this Section prior to the transfer. Important results have been obtained by isolating a bacterial mutant which uses NTA as sole carbon, nitrogen, and energy sources at temperatures as low as 4°C. Special bacteriological studies were conducted in connection with the Lake Erie organic particle study, the Lake Ontario thermal bar phenomenon, and sediments in Lake Erie and Lake Ontario.

Primary Production and Algae in Great Lakes

Surveys and analyses by the Fisheries Research Board group of primary production data (by chlorophyll *a* a C^{14} assimilation) gave evidence of relative production Lakes Ontario, Erie, and Huron. Average C^{14} assimilati values in Ontario were 1.7μgC/1/h in winter a 12.5μgC/1/h in summer with a maximum inshore value 43.9μgC/1/h. Lake Erie averages ranged from 5.1μgC/1/h 32.0μgC/1/h with an absolute maximum of 228.0μgC/1, Production values for Lake Huron are much lower, exce for Saginaw Bay. For Lake Ontario, 374 species plankton algae were recorded of which only 70 had be reported from earlier studies of the Lake.

Wastewater Treatment — Nutrient Removal Studies

In addition to the continuing study of paramet affecting "luxury uptake" of phosphorus at the Drury La treatment plant, Burlington, Ontario, studies were initiat on the optimum phosphate removal process applicable a number of Department of National Defence (DND) bas The effects of detergent formulation on phosphate remo at treatment plants are under investigation at the DN base, Gloucester. A study of the possible use of quickli for phosphorus removal was initiated at the pilot plant.

Mercury in Sediments

Sampling was completed for assessment of merc distribution in surface sediments of the Okanagan La system (B.C.) and the Nottaway River system (Quebec) well as in Lake Huron. In Lake Huron the average is ab 0.2 ppm with anomalous high values generally less tha ppm, significantly lower than values reported earlier sediments of Lake Erie and Lake Ontario. A contract w H.G. Acres was started to assess the possibilities of dredg or burying highly contaminated areas of Great La sediments to prevent the mercury and other contamina from entering the food chain.

Okanagan Study

Sampling and field data collection phases of La Division's contributions to the federal-provincial Okana Basin Study were completed in October 1971 and repo are in progress.

Waste Heat Discharges

Studies are nearly completed of the temperature eff of projected waste heat discharges on waters of the G Lakes. The Hydraulics Division produced an impro solution for equations governing dispersal of waste hea rivers. At the same time a contract study by Mont Engineering of waste heat discharges across Canada dicates that these will increase from 2.86×10^{10} BTU/h 1970 to 76.7×10^{10} BTU/h by the year 2000.

hematical Modelling of Lake Systems

Significant progress was made in mathematically model- lake systems to lead to the prediction of circulation nearshore dispersal of conservative pollutants. Good lts were obtained with a four-layer stratified model. ther verification of models through data collected in GL will be of a major importance in 1972 and 1973.

at Lakes Water Uses

A map published by the Lakes Management Research ion and the Resources Research Centre, Ottawa, on at Lakes waste use has proven to be a most useful and ular publication. In graphic form it shows population sities, water withdrawals, waste discharges, fish catches, eration of electrical energy, shipping statistics, and ated crop acreage.

rnational Field Year for the Great Lakes (IFYGL).

Plans were nearly completed for IFYGL, the inter- onal Hydrologic Decade program on Lake Ontario. fts of an internationally coordinated four-volume tech- l plan were completed, covering the scientific program, acquisition system, operation plans and schedules, the data management plan. IFYGL will be the most prehensive physical-chemical-biological study of a ma- lake ever attempted and major ship and scientific urces of both U.S. and Canada will be deployed during the field program from April 1972-March 1973.

Advisory Committee and Project Planning

The Advisory Committee to CCIW continued to provide advice on program development at the Centre directly through subcommittees on hydraulics, and waste treatment research, and on university and private sector use of CCIW facilities. Arrangements have been made for a number of university professors and their students to spend sabbatical years or shorter periods working at the Centre in 1972. A new project forecast form was developed and introduced for Centre's use and to provide information on project plans for comment by the Advisory Committee.

Future

The occupation of the Centre's Laboratory and Administration building and Hydraulics Laboratory will speed up the implementation of CCIW programs in 1972. Signing an agreement with the United States on pollution control of the Great Lakes will involve extensive follow-up activities by CCIW staff. The year's major field program will be conducted on Lake Ontario in the IFYGL. Major expansion of the multi-disciplinary program on environmental impact of new and toxic substances is planned and completion of equipment for the Water Quality Pilot Plant will permit full development of wastewater treatment studies and demonstration projects.

Inland Waters Branch and Fisheries Research Boa
Research Components

HYDRAULICS UNIT

Equipment

The Hydraulics Unit is responsible for operating a national calibration centre for hydrometric instruments and for research and tests in waves, fluid dynamics, sediment transport and problems encountered with ice and cold environment.

In April a contract was given to Westinghouse Canada Ltd. to supply a towing carriage equipped with precise control and data acquisition systems to serve the national needs in hydrometric calibration, particularly for current meters and sediment samplers. The primary performance specifications are:

Minimum steady velocity	0.5 cm s^{-1}
Maximum steady velocity	600 cm s^{-1}
Allowable variation in velocity	±1%

In the towing tank (Figure 1) – 122 m long, 3 m deep, and 5 m wide – up to four current meters may be calibrated simultaneously. It is expected that the towing carriage will be in operation by October 1972.

Considerable time was devoted to developing the design by a consultant of a 2 m wide x 27 m long tilting flume for sediment research. This rather unique flume empties into sediment traps with a normal capacity of 10 cubic meters of sand and has a maximum flow of 0.8 cubic meter per second (30 cfs). Another tilting flume 1 m wide by 26 m long was also designed for general purposes. Both these flumes will be constructed in 1972. Specifications have also been drawn up for cold rooms designed especially for hydraulic research. These cold rooms pose special problems in design because of high humidity and heat load from water surfaces in the rooms. One of the rooms is being designed to torture test instrument packages under simulated weather conditions. The other will be designed for a wide range of experiments connected with the use and control of water in a cold environment.

Design and conceptual work was also undertaken for a proposed wind wave flume which will be 4.5 m wide by 114 m long overall. Studies of the air flow, the heat budget and the mechanical generation of waves were undertaken as a preliminary to having engineering designs performed by private industry.

Research Activities

Research activities have been quite varied and succe although restricted to theoretical and office studies the laboratory is completed in July 1972.

Studies of the discharge of waste heat into river f resulted in an improved solution for the diffusion equ and procedures were recommended for calculating temperature distribution downstream of a source. M improved estimates of temperature due to warm disch are now possible. As a result of this work, a parallel ana was undertaken of the dispersion process and decay o Biological Oxygen Demand of an effluent entering a Preliminary reviews of the present knowledge of transfer process of oxygen into flowing water revealed

Figure 1. Towing tank under construction, February 19

only several theories but also that empirical relation- were inconsistent.

rather comprehensive review of the problems caused combined storm and sanitary sewer systems and by n water runoff was undertaken. The study found that h could yet be done towards finding economically and nologically feasible methods of treating large flows of n water or combined sewage.

Problems in sediment transport and erosion germane to ronmental control and engineering developments were r active review. An early conclusion is that field surements may often lack sufficient precision and that e is a great need to seek methods of improving the estimation of sediment transport in nature. Bed load measurements, for instance, are very difficult to obtain.

Advisory Working Group

During the year, a Working Group in Hydraulics was formed to provide advice and priorities on national needs for hydraulic research. Members for the Working Group are drawn from private industry, federal government groups and some universities. The Group is not primarily research oriented but composed of designers and managers concerned with water resource management. At their second meeting the Working Group prepared a list of proposed research areas in sediment, snow and ice, waves, and fluid mechanics and also indicated relative priorities.

LAKES DIVISION

The objective of Lakes Division, within the broad terms ference of the Department of the Environment and the r Management Service, is to provide the government the scientific knowledge needed for managing the water resources stored in lakes of Canada. Accord-, Lakes Division has two basic functions: a) to orm basic research with a view to increase scientific wledge in the field of limnology, i.e., the science of s and lake behaviour or processes; b) to deliver the tific tools needed by management to solve present and re environmental problems related to lakes.

As organized in 1971, Lakes Division consists of four ntific sections; physical limnology, limnogeology, chem- limnology, and biological limnology. This latter group eing seconded to Lakes Division from the Freshwater itute, Winnipeg, Man., of the Fisheries Research Board. ddition to these Sections a separate Technical Opera- s Section carries responsibilities for planning and lementation of the field operations connected with the ntific programs and gives assistance to other sections in handling and data analysis.

In considering the multidisciplinary nature of a large tion of Lakes Division's activity a new organization plan been developed recently. The reorganization should vide a greater flexibility to meet interdisciplinary gram needs.

BIOLOGICAL LIMNOLOGY (FISHERIES RESEARCH BOARD)

Dr. A. Nauwerck, Acting Head, FRB Detachment logical Section) from November, 1970, has been appointed Head of the Detachment since May 1, 1971. However, Dr. A. Nauwerck returned to Sweden at the end of January, 1972, and Dr. W.A. Glooschenko took over as Acting Head.

Staff activities have been concentrated in two fields: the monitoring of the Great Lakes biological features, and the testing of substances of possible impact on lakes ecology such as nutrients, toxic and chelating compounds.

The monitoring efforts were concentrated on Lake Huron, while Lake Ontario, Lake Erie, and Lake Superior were covered by repeated research cruises. A considerable part of the time was also devoted to the interpretation of the data collected in 1970.

Phytoplankton

For Lake Ontario, 374 species of plankton algae were recorded. Only about 70 of these had been observed in earlier studies of the lake. In several taxonomical groups, particularly in the genera *Stephanodiscus Oocystis* and *Cryptomonas,* a considerable morphological variability was observed and was studied separately. The investigation indicates that morphological variability is a much more sensitive indicator of environmental conditions and changes than are species composition and species diversity, which in contrast to European experience, seem to be of limited significance in north American lakes. Another study on the phytoplankton of 8 Yukon lakes and of 5 lakes on Cornwallis Island confirmed that species known as eutrophication indicators can appear in dominating numbers in quite untouched, oligotrophic lakes, and that arctic waters may have practically the same species composition as, e.g., Lake Ontario has through winter and spring. Thus, the main difference in the phytoplankton of the Great Lakes is in

quantity rather than in quality. Nevertheless, significant differences are notable even in species composition.

Phytoplankton biomass in the epilimnion of Lake Ontario was found to have a typical inshore-offshore development and, in spring, shows a clear relationship to the development of the thermal bar. Only one pulse is established in late summer in the open lake, reaching a maximum of almost $90 \times 10^5\ \mu^3$/ml while repeated pulses are common throughout the year in the inshore region, and the average plankton volume there is $33 \times 10^5\ \mu^3$/ml compared to $26 \times 10^5\ \mu^3$/ml in the open lake.

The dominant groups in the phytoplankton biomass of Lake Ontario are diatoms, cryptomonads and green algae; the diatoms have a spring maximum, the others have a late summer maximum (Figure 2).

A more pronounced summer dominance of green and a relatively higher number of dinoflagellate chrysomonads were found in Lake Erie. Water blo blue-green algae, observed frequently during summer western basin of the lake, did not add drastically total biomass, even if they sometimes dominate samples from that part of the lake.

During the ice-free period of the year, pl volumes in western Lake Erie were about twice as hig the eastern lake, and almost 4 times as high as comp values from Lake Ontario, while central Lake Erie s values that were rather lower than the ones from Ontario.

Chlorophyll

Corresponding results were obtained for the epi

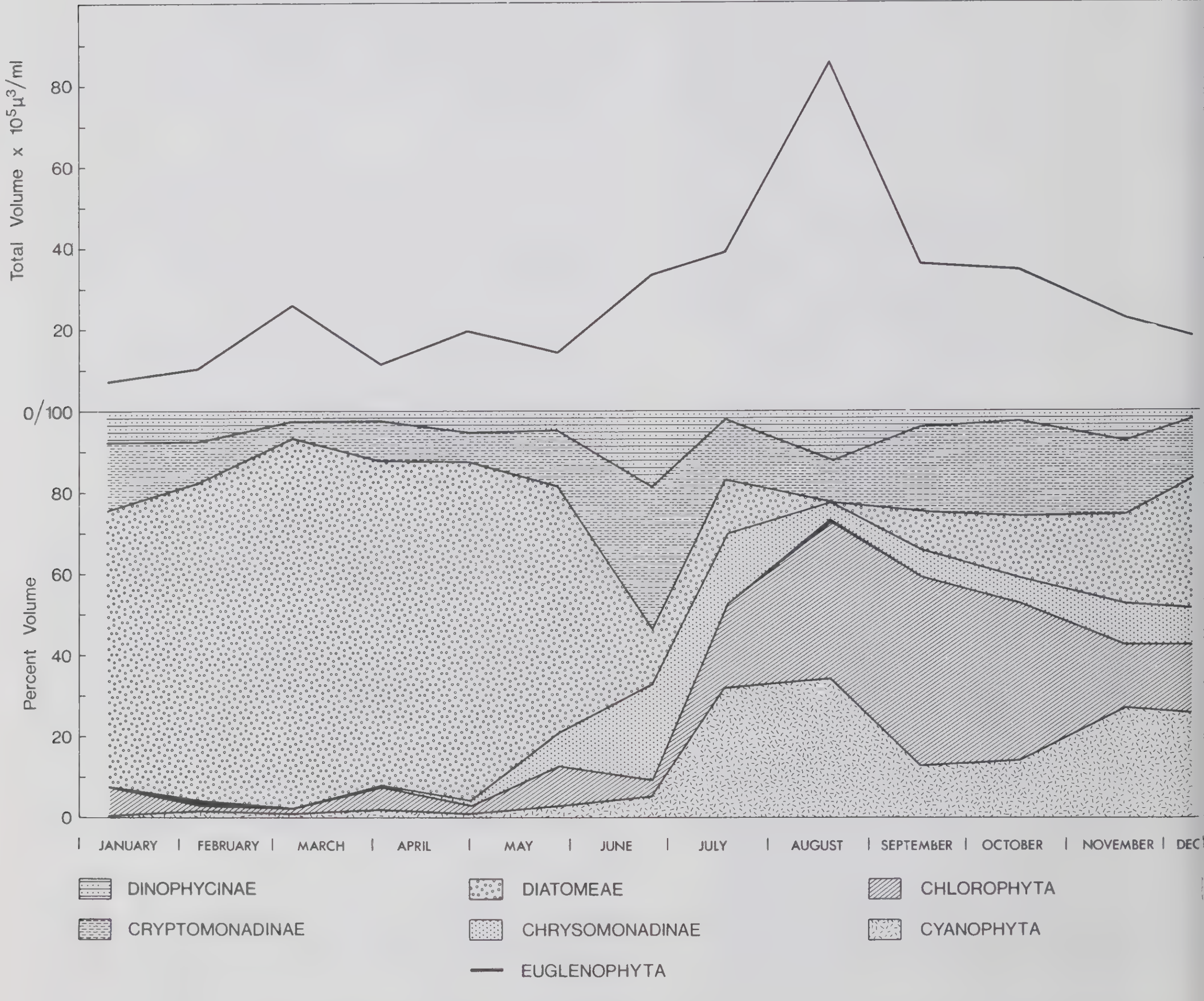

Figure 2. Annual distribution of phytoplankton biomass in Lake Ontario with species composition of major groups.

rophyll distribution in the lakes. The annual cycles of rophyll a and pheo-pigments of Lake Ontario were lied on 32 stations during 13 cruises between January December, 1970.

Highest amounts of chlorophyll a were found in inshore ers, particularly along the southern shore from east of hester, N.Y. to the St. Lawrence River. In terms of the onal cycle of phytoplankton biomass as measured by rophyll a; three types of cycles were seen: (1) a modal distribution in the deeper waters which are last to m up in the late spring; (2) a bimodal pattern with ng and fall peaks mainly along the central basin and th and south shores; and (3) a series of three pulses in rient-rich areas and in the warmer eastern region of the . Zooplankton biomass increased eastward in the ction of increasing heat content.

Low values of pheo-pigments were seen during the ng increase of phytoplankton. However, the relative unt of pheo-pigments compared with chlorophyll a was ificantly correlated ($r = +0.896$) with zooplankton ndance (Figure 3). The highest percentage of pheo-nents were found in the eastern basin of the lake confirming the observed sedimentary distribution of these pigments. Grazing appears to be the main mechanism by which pheo-pigments are produced in the lake. However, resuspension of bottom sediments in shallow waters may be important locally. The need to correct chlorophyll a values for pheo-pigments is emphasized especially during times of the year when zooplankton grazers are abundant.

Chlorophyll data for Lake Erie in 1970 have been analyzed in detail. Average values and ranges of chlorophyll a (μg/l) in eastern, central, and western basins of Lake Erie 3.2 (2.2-6.6), 4.4 (2.6-6.8), and 8.9 (4.2-11.1) respectively. No distinct seasonal cycle of chlorophyll could be found in the eastern basin where peaks of repeated pulses occurred at the stations studied. The central basin shows a summer peak, but a spring maximum may have been missed due to April being the earliest sampling month. The western basin has a large late summer bloom. No vertical stratification of chlorophyll has been noticed during Project LEPS cruises.

Primary Production

Primary production was measured by the C^{14}-method in a shipboard incubator. Average assimilation values for the open waters of Lake Ontario varied in 1970 between

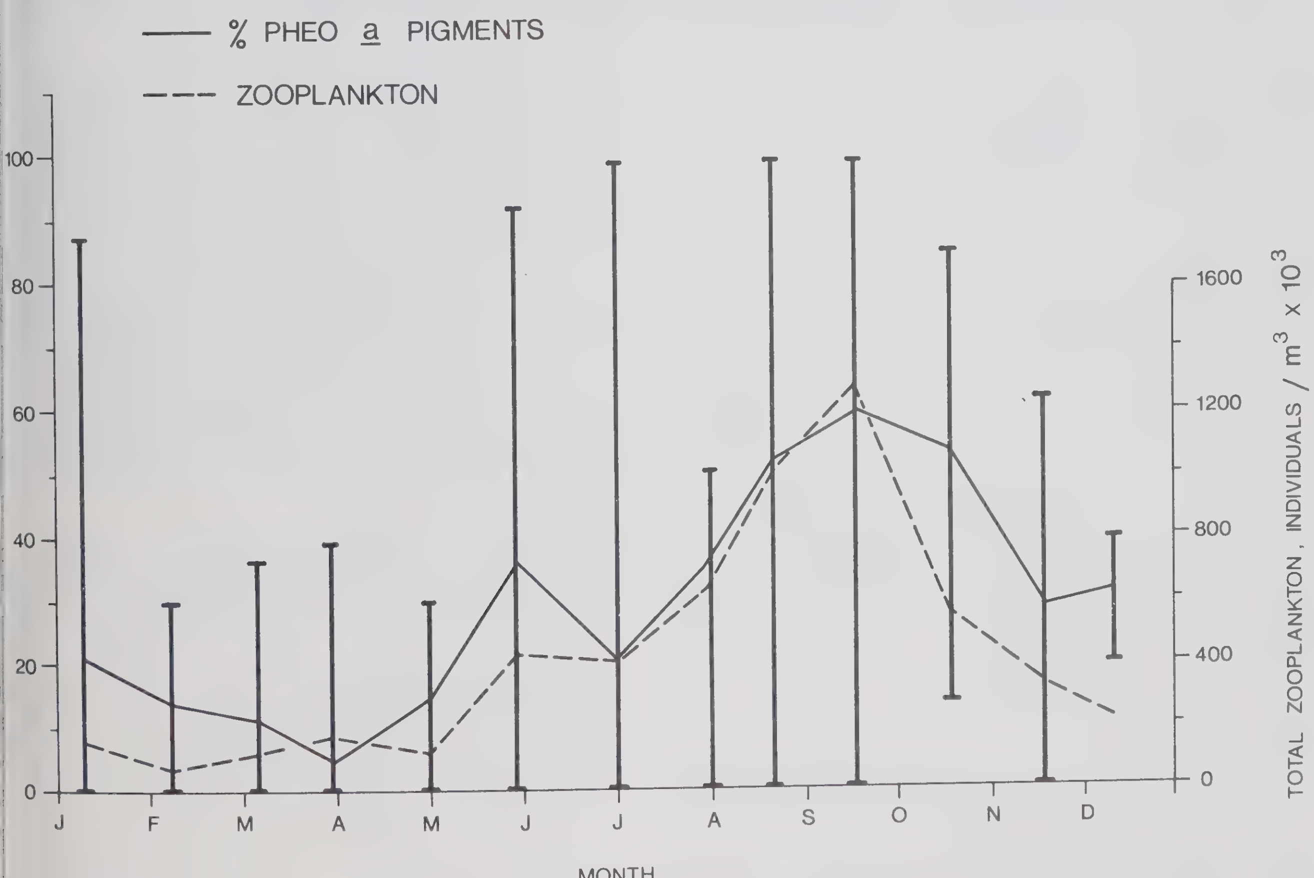

Figure 3. Relationship between pheo-pigments and zooplankton abundance in Lake Ontario.

1.7 μg C/1/h in winter and 12.5 μg C/l/h in summer. In the inshore region the highest assimilation values were found in spring and averaged to 25.0 μg C/1/h in late May. The highest single inshore value obtained was 43.9 μg C/1/h.

In 1970 the average values in Lake Erie varied between 5.1 and 32.0 μg C/1/h. The highest average values were: in the eastern basin, 13.9 μg C/1/h; in the western basin, 146.9 μg C/1/h and in the central basin 71.4 μg C/1/h. The absolute maximum 228.0 μg C/1/h, was found in the western basin in summer (Figure 4).

The assimilation of C^{14} shows a direct linear relationship with chlorophyll *a* in all the lakes. Lake Erie C^{14} assimilation per unit of chlorophyll *a* was greater than in Lake Ontario.

Zooplankton

A species study was carried out on the planktonic rotifers of Lake Ontario. Forty-five species were noted, one of which had been discovered previously in North America, and another one, considered to be extremely rare, which was found to be common.

Most important, quantitatively, were *Polyarthra vulgaris, Keratella cochlearis, Synchaeta lackowitziana* *Keratella earlinae*. The highest numbers of rotifers appe in July and averaged several hundred individuals per lit the epilimnion. Thus, the biomass of the rotifers may e occasionally that of the crustaceans, which makes ro an important part of the secondary producers.

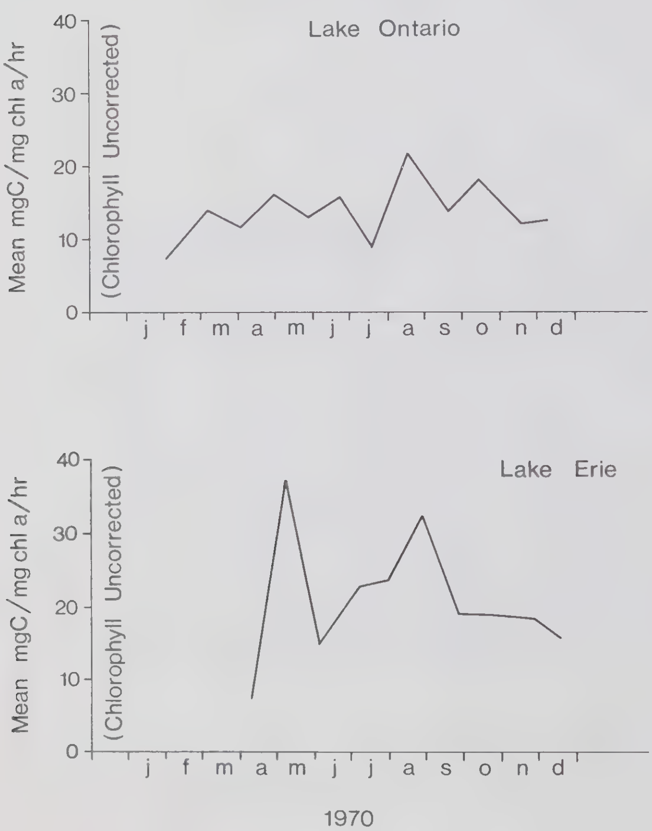

Figure 4. Comparison of seasonal cycle of carbon assimilated per unit chlorophyll *a* in Lakes Erie and Ontario.

Altogether 25 taxa of crustaceans were found in Ontario, of which 3 were previously recorded from lake. Crustacean plankton in the epilimnion of Ontario was found to develop one peak in late sum with a lake average of 50 individuals/1, the annual av being 17.4 individuals/1. Cyclopoids, with domin *Cyclops bicuspidatus thomasi* and cladocerans, dominating *Bosmina longirostris*, were almost eq important, quantitatively, while Calanoid copepods r sented only 2% of all individuals. In winter, how almost only copepods are found in the lake.

As an annual average, inshore regions showed app mately twice the population density of the open lake there is a distinct preference of offshore regions in calanoids and in the adults of *Cyclops bicuspi thomasi*. The relative amount of Cladocerans, partic of *Daphnia, Ceriodaphnia* and *Chydorus*, was highe eastern and northeastern regions of the lake (Figure 5)

In Lake Erie, for comparison, during the ic period, the average number of Crustaceans was more t times that of Lake Ontario. Percentage compositio 57% Cyclopoids, 38% Cladocerans and 5% Calanoids main difference was in the relative importance of *Bo longirostris*, which was almost lacking in Lake Eri comprised 29% of all Crustaceans in Lake Ontario. An difference was the very high amount of *Chy sphaericus*, particularly in the western basin of Lake In contrast to Lake Ontario, Lake Erie showed a two development of the zooplankton with a maximum in summer and in a late fall. Highest concentrations found in the western basin as early as June and amo to over 1300 individuals/1.

In Lake Huron, in 1971, crustacean numbers from a few to some ten's of individuals per litre in the lake but did not attain 100 individuals/1 in Saginaw B

A strong correlation could be established be phytoplankton biomass and egg production in *C bicuspidatus thomasi* in Lake Ontario. For *Bosm* similar correlation existed, but the data indicate a subtle dependence of egg production on food quality.

Preliminary results on the population dynamics dominant species show *Limnocalanus macrurus*, cyclic; in most of the other copepods one long

ration and 2 - 3 short summer generations; and in most he cladocerans 10 - 20 summer generations depending emperature.

Diurnal migration was found in all species, its amplitude ending mainly on the size of the animal. The migration litude also was clearly dependent upon the season and most marked during late spring, i.e., at the most -intensive time of the year.

Bottom fauna

Another special study was devoted to *Mysis relicta.* This semi-planktonic species appears to be monocyclic, in Lake Ontario and in Lake Huron and shows a strong nocturnal migration from the bottom sediment to the uppermost layers of the lake. In winter, the animals are distributed over most parts of the lakes, but the females occur more commonly on inshore regions. In summer, there is a direct

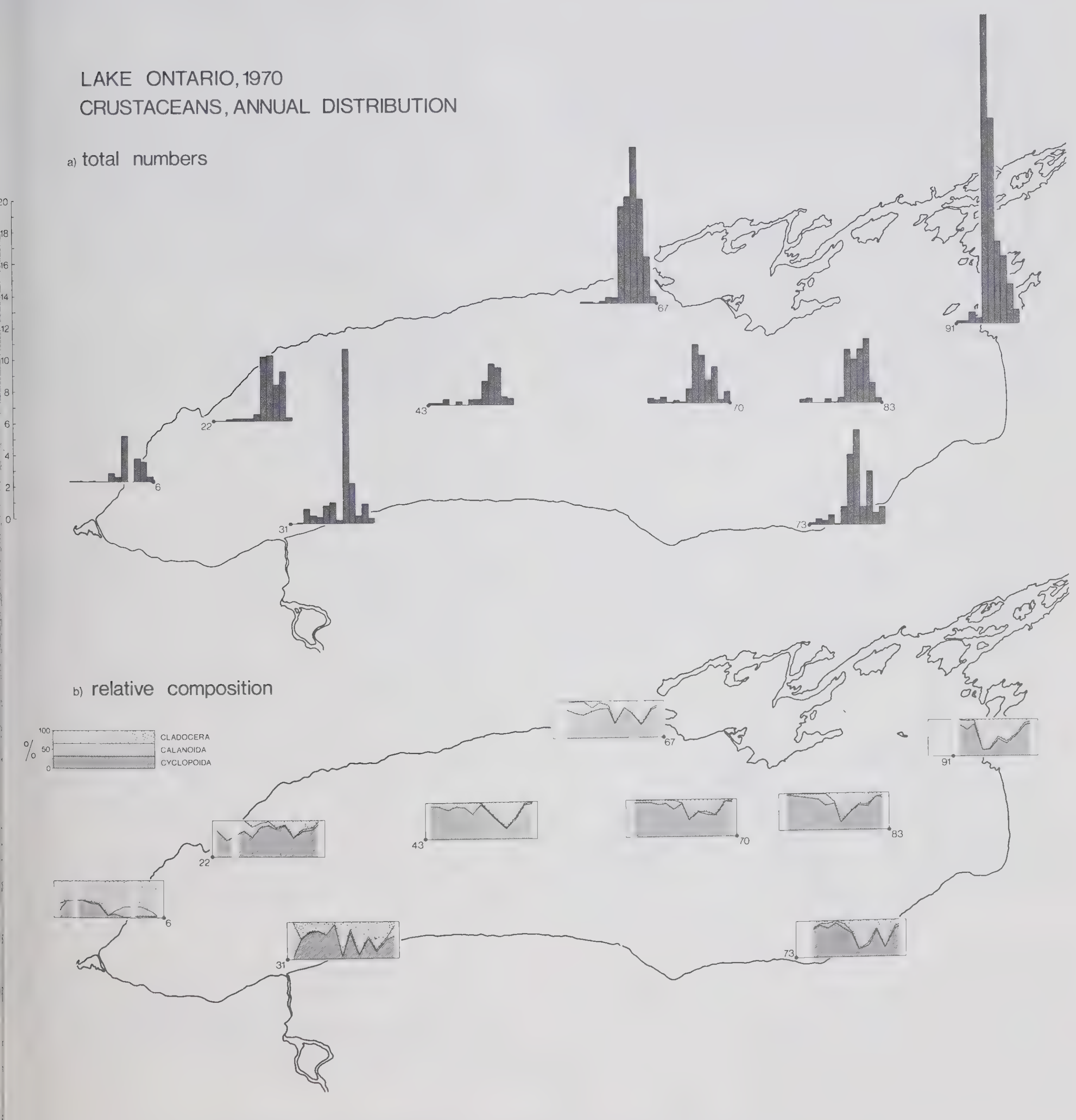

Figure 5. Annual distribution of crustacean zooplankton in Lake Ontario.

relationship between depth and numbers of animals per square unit. The average number of animals was around $30/m^2$ in Lake Huron, twice as much in Lake Ontario and 5 times as much in Lake Superior. Calculated per water volumes, the numbers are 0.5, 1.0; and 1.2 individuals/m^3, respectively. In Lake Erie only a few individuals were found averaging to 0.7 individuals/m^2 or 0.03 individuals/m^3.

Bottom fauna studies also comprised a survey over Lake Huron and an investigation of Hamilton Harbour, Lake Ontario. In Lake Huron, an average of 880 organisms/m^2 was recorded from over 80 stations all over the lake. *Pontoporeia hoyi* and *Stylodrilus heringianus* with 33% and 19% of all individuals were the dominants. The average dry weight of the macrobenthos was found to be 1.36 $\mu g/m^2$, composed by Amphipoda, 0.39 $\mu g/m^2$, Oligochaeta, 0.13 $\mu g/m^2$, Chironomidae, 0.12 $\mu g/m^2$, and Mollusca 0.72 $\mu g/m^2$.

In Hamilton Harbour, *Limnodrilus hoffmeisteri* was the dominant species, representing 62% of the profundal Oligochaete community. A number of species, mainly molluscs, could be considered as new-comers to the Bay since the installation of a sewage primary treatment plant at the outlet from the City of Hamilton. Hence, the total biomass of bottom fauna is still increasing.

Bioassays

Experiments with the addition of nutrients and me compounds to lake water and the study of algal response assimilation rate, continued in the upper Great Lakes. was found that significant positive and negative reacti on all added substances, (P, N, Fe, Mn), were m common in spring. In summer the number of signific reactions was low, and in fall they were mainly negati This result indicates that (1) normally no single facto limiting assimilation and (2) algal physiology is depend on the season and determines the outcome of the ex riment rather than the added substance *per se.*

Bioassays using mixed phytoplankton algae from L Ontario and Hamilton Harbour in order to evaluate effects of sodium citrate indicated that chelation was most probable mode of action of citrate upon algal grov The interaction of zinc, copper, sodium citrate, and ED showed citrate to be a relatively weak chelating compou compared to EDTA. (Figure 6).

Lake Huron

Several conclusions may be drawn from prelimin interpretations of data from Lake Huron. With the exc tion of Saginaw Bay, chlorophyll *a* values are low-avera

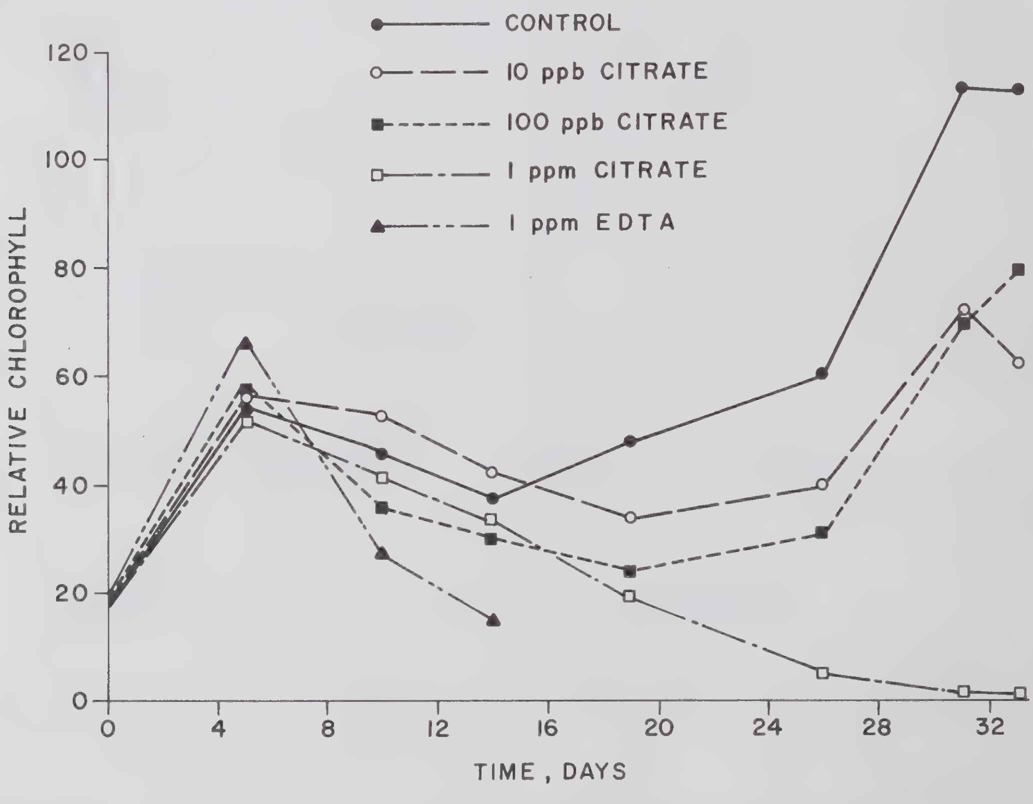

Figure 6. Effect of addition of citrate on algal growth from Hamilton Harbour.

n April to December are from 1 - 2 μg/1 over most of lake except the western shore from the mouth of inaw Bay to St. Clair River where 2 - 4 μg/1 were found. the Bay, sharp gradients from 4 μg/1 at the mouth to 24 1 at the head occur indicating an extremely eutrophic ironment. Neglecting the Bay, the seasonal cycle of orophyll *a* is mainly bimodal with vernal and autumnal ks and a summer minimum which is less than 50% of the k values. A slight summer maximum is found in the er central portion of the lake. Primary production ched a maximum in late September; neglecting Saginaw , maxima of about 4.5 mg $C/m^3/h$ occurred. Primary duction increased directly with temperature in a linear nner. Assimilation ratios reached a maximum of approx-tely 3 mg C/mg chlorophyll *a*/h comparable to the hest values found in Lake Erie. Nutrient enrichment eriments showed positive responses to nitrogen and sphorus to occur in the spring and fall but negligible or ative responses were seen in the summer.

CHEMICAL LIMNOLOGY SECTION

During 1971 the staff was engaged in a variety of arch projects: applied lake-study, a continuing study of chemical quality of atmospheric precipitation, develop-ntal projects on analytical methods and cycles of trace nents and soluble organic compounds (including NTA), c laboratory research on the stabilities of authigenic osphate minerals and the physical chemistry of aqueous tions.

The applied lake study projects include continuing ntion to the Chemical Monitor Cruise Program on the at Lakes; a replicate sampling program to provide istical assessments of the quality of the data; winter dy of Lake Erie from the icebreaker, the CCGS N.B. Lean; monthly cruises of the CSS LIMNOS on the tral Basin of Lake Erie from May to December – the ises being used for a variety of special projects; the mistry of interstitial water of the bottom sediments, ole isotopes of carbon and sulfur; and bottom sampler instrument development.

The collection of samples of rain and snow continued, a variety of special purpose samplers were developed evaluated.

Development continued on procedures for separating identifying organic compounds in lake water, and a ll-scale NTA monitoring program was set up. Research tinued on the detection and chemical speciation of trace als in lake water.

Specialized laboratory research projects included asurements of the stabilities of authigenic iron-phosphate minerals and the associated equilibrium water chemistry, the physical chemistry of aqueous solutions, e.g., the measurements of activity coefficients of solutes and solubilities of salts in three component systems.

Chemical Monitor Cruises

The Chemical Limnology Section was responsible for planning and evaluating results of the Chemical Monitor Cruises on the Great Lakes, although most of the work of sampling and chemical analysis is done by staff of the Technical Operations Section and of the analytical detachment of the Water Quality Division. The emphasis was on Lake Huron, eight cruises being carried out between April and December. As part of their input to the Monitor Cruise Working Group, M.T. Shiomi and K. Kuntz provided contoured charts of surface distributions of soluble nutrients for each of the Lake Huron and Lake Superior cruises.

A replicate sampling program was undertaken to obtain statistical evaluation of the quality and reproducibility of the chemical monitor cruise data. Standard deviations of the procedures were obtained from quintuplicate determinations at six stations during cruises on Lakes Huron, Erie and Ontario. The means of the five cruise standard deviations and the mean ranges over which they were determined are:

Dissolved oxygen	0.10 mg/1	10.98 – 12.12
pH	0.03 units	8.10 – 8.32 units
Specific electrical conductance	3 μmho/cm	224 – 257 μmho/cm
Total alkalinity, filtered	0.6 mg/1	74.2 – 82.6
Total nitrate, filtered	0.009 mg/1	0.162 – 0.255
Soluble reactive phosphate, filtered	0.001 mg/1	0.004 – 0.013
Soluble ammonia, filtered	0.002 mg/1	0.005 – 0.030
Nitrite, filtered	0.0005 mg/1	0.0014 – 0.0047
Reactive silica, filtered	0.093 mg/1	0.737 – 1.282
Turbidity	0.7 units	0.7 – 6.4

The large dispersions in phosphate, ammonia, and nitrite values probably stem from the fact that the levels of these components were at or near their detection limits. Silica and turbidity standard deviations are high and it is hoped efforts will be made to improve methods of sampling and analysis. The other values all represent a small fraction (less than 5%) of the determined values.

An unexpected opportunity to survey and sample Lake Erie during the winter was provided when space was made available on the CCGS icebreaker N.M. McLEAN; ice and water samples were taken. The water column was homogeneous at all stations and dissolved oxygen was at or near saturation. Soluble nutrients were near their annual highs except for silica which was low, suggesting some diatom growth, even under ice.

Analysis of the melted ice yielded inconclusive results, showing no patterns with respect to sampling location, ice thickness, or nearness to the water. However, ice formation and movement may be an important part of Lake Erie's annual cycle, as some of the ice contained large amounts of particulate matter, and assayed very high (~ 1.7 mg/1) in particulate phosphorus.

Interstitial Water

Sediment cores from three stations in the central basin of Lake Erie were collected at monthly intervals from May to October, to study the chemical properties of the interstitial water and the effects of seasonal changes in the chemistry of the overlying water.

The hypolimnion of the central basin warms over the summer from about 7°C to about 15°C, while the oxygen content of the bottom water decreases in large areas to zero. During the same period, chemical changes were seen in the interstitial water, most markedly near the sediment-water interface. The pH and Eh decreased, and Ca and Mg content and alkalinity increased. Except for sulphate, the interstitial waters were enriched in nutrients relative to lake water. Sulphate content decreased with depth and alkalinity and the amount of ammonia increased. These observations are in agreement with the interpretation that carbonate and silicate minerals in the bottom sediment are slowly being dissolved.

Stable Isotopes of Carbon and Sulfur

Samples of water, interstitial water, and plankton were collected from Lake Erie for a preliminary evaluation of the value of carbon isotope analyses in lake studies. The C^{13}/C^{12} ratio has been determined for some of the water samples on the special mass spectrometer in the laboratory of Dr. H. Schwarcz at McMaster University. The following tentative conclusions have been drawn:

1) The δC^{13}* of the surface waters in both lakes ranges from about +0.6 to about -0.5 $^{0}/_{oo}$, suggesting that the surface waters are in equilibrium with atmospheric CO_2.

2) The δC^{13} of the water just off the bottom, i.e., below the thermocline, is more negative, indicating that CO_2 from decomposing organic matter is added to the water. In Lake Erie the δC^{13} becomes more negative as oxygen is depleted in the hypolimnion.

Information was also obtained on the isotopic sulphur composition in lake water, algae, and the sediment. The abundance of isotopic sulphur in the lake water is remar ably uniform (mean δS^{34} value of six samples is +4 $^{0}/_{oo}$, with the standard deviation of 0.2 $^{0}/_{oo}$). It somewhat surprising that the isotopic data for the algae essentially identical (mean value for three samples is +4 $^{0}/_{oo}$) to that of the lake water. Typical of the syngenetic diagenetic sulphides resulting from biogenic activities, t sulphur in the sediments shows widely scattered δS values ranging from -10.8 to +15.1 $^{0}/_{oo}$. While a detail interpretation of the data is not feasible at this stage, t preliminary results to indicate the potential importance stable sulphur isotopic analysis in environmental studies.

Bottom Sampler and Instrument Development

A large area (0.28 m^2) diver-operated, interface sampl was developed for the purpose of observing sediment-wat processes in the laboratory with the interface in its natu condition. The sample obtained is large enough to be set as a test tank in the laboratory with controlled circulati and has been used in measuring sediment oxygen dema under conditions in which some variability of natu conditions has been removed; it can also be used for a lar number of different investigations. At present the samp cannot be used at depths greater than 100 ft. due to di limitations, however, the experience gained in developi the instrument will be used in the subsequent developme of a diver independent interface sampler.

Work has progressed on the development of an *in si* instrument to measure settling rates and settling fluxes algae and suspended minerals. This "sedimentation bott will be used in studies of nutrient cycling in lakes and in transfer of quantities of materials from the epilimnion the hypolimnion during stratified periods.

Rain Chemistry Project

Another station located at Sarnia Airport in the La Huron Basin was added to the sampling network of Rain Chemistry Project (Figure 7). The sampling netw now comprises a total of 16 sampling stations in Laurentian Great Lakes basin – 8 in the Lake Onta basin, 3 in the Lake Erie basin, 3 in the Lake Huron ba and 2 in the Lake Superior basin. Bulk precipitat (rain-fall and dust-fall combined) samplers are used at all these stations and each month's collection of bulk prec tation is analyzed. For over 2 years, chemical d have been accumulated from the Lake Ontario ba stations and for about 1 year from the rest of the stati with exception of the new Sarnia Airport station.

More detailed investigations into the chemical natur precipitation are carried out at the site of the Car Centre for Inland Waters. Automatic rain samplers w collect only rain-fall or snow and not dust-fall have b

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$$^{*}\ \delta C^{13} = \left(\frac{C^{13}/C^{12}\text{ sample} - C^{13}/C^{12}\text{ standard}}{C^{13}/C^{12}\text{ standard}} \right) \times 1000$$

Figure 7. Rain chemistry project, station locations, Dec. 1971.

uired. These samplers were modified before use, in-porating heating elements for winter operation and wind ectional sensors. The latter modification enables us to lect the rain or snow only when the wind is blowing in a tain specified direction. It is hoped that by using a mber of these samplers together, all fitted with this dification, it will be possible to determine qualitatively effect of specific air pollution sources on the chemical mposition of the rain collected. Three of these samplers ve been in operation at the CCIW since late September. special experiments into rain chemistry will be re-icted to the CCIW site for the present time.

ganic Compounds in Lake Water

Work begun in 1970 on the chemical properties of NTA (nitrilotriacetate) now being used in Canada as a substitute for polyphosphates in laundry detergents, was essentially completed in 1971, and several papers were published (Chau and Fox; Childs; Lerman; Chau and Shiomi). Towards the end of 1971, the emphasis turned toward monitoring the levels of NTA, now present in near-shore waters.

Detection of low concentrations of NTA in water involves an extraction by an anion exchange resin, preparation of the propyl ester and gas chromatography. Some other organic acids in this molecular – weight range will be carried through this procedure.

Water samples from Lake Huron, Lake Erie, and Lake

Ontario were analyzed for NTA, using large enough samples to permit the detection of <1 μg NTA/1. NTA was detected only in the Lake Ontario sample, but, interestingly, different arrays of background peaks were obtained for the various samples of lake water. This procedure shows promise for "fingerprinting" different waters and for characterizing a number of soluble organic compounds.

Dissolved organic material in lake water is generally present in lower concentrations than can be isolated and identified by standard chemical methods or by most instrumental techniques, so various methods of extraction and preconcentration were investigated. A continuous extraction apparatus was designed for use with immiscible solvents of different densities than water, and capable of accommodating large (8 l) samples. An efficient preconcentration technique involves use of a Virtis Freeze Concentrator which provides approximately a ten-fold concentration of dissolved material in water, and ultra-pure ice. The preconcentration cannot be carried further due to a precipitate, presumably $CaCO_3$. The precipitate is caused chiefly by the hardness and high alkalinity of most Great Lakes water.

Trace Elements in Lake Water

A PAR Model 170 Electrochemistry system was acquired for applications in trace metal analysis and studies of chemical speciation in lake waters. Considerable time was spent in optimization of the instrumental parameters of operation in the various modes of polarography. This polarographic technique is capable of direct and simultaneous determination of several metals in lake water at the μg/1 concentration level. Methods have been established to differentiate between a metal in a free ionic state and in a complexed form.

A special project on the chemical forms of Hg in lake water shows that little, if any, is present as methyl mercury.

Solubilities of Authigenic Phosphate Minerals

A knowledge of the solubilities of authigenic phosphate minerals is relevant to the question of the geochemical migration and fixation of phosphorus and the various metals in soils and sediments. The solubilities of important phosphate minerals are now being determined using a saturator which allows the aqueous solvent to percolate through a cascade of the phosphate beds. The analytical data on the leachates are computer processed to obtain the solubility product constants and the association constants for any ion-pairs.

The results obtained so far are encouraging. For example, measurements on vivianite $[Fe_3(PO_4)_2 \cdot 8H_2O]$ suggest that $FeH_2PO_4^+$ and $FeHPO_4^0$ may be important species in reduced aquatic systems and the formation this mineral may be significant in regulating the P and levels in natural waters and in anaerobic digester sup natants.

Physical Chemistry of Aqueous Solutions

Measurements of the activity coefficients of bri analogs containing two salts are now essentially comple as are measurements of solubilities in two-salt solutic using the isopiestic technique of Kirgintsev a Trushnikova[1].

The following parameters were determined:

(a) The activity coefficients, and the solubilities at eutectic at 25° and at 0° of the systems:

$H_2O-NaCl-MgSO_4$
$H_2O-NaCl-Na_2SO_4$
$H_2O-K_2SO_4-Na_2SO_4$

(b) the activity coefficients at 25° of the systems:

$H_2O-NaCl-K_2SO_4$
$H_2O-KCl-Na_2SO_4$
$H_2O-KCl-K_2SO_4$
$H_2O-MgCl_2-Mg(NO_3)_2$
$H_2O-MgCl_2-Ca(NO_3)_2$
$H_2O-CaCl_2-Mg(NO_3)_2$
$H_2O-CaCl_2-Ca(NO_3)_2$
$H_2O-Mg(NO_3)_2-Ca(NO_3)_2$

(c) the activity coefficients at the freezing point of binary systems:

$H_2O-Na_2B_4O_7$
$H_2O-K_2B_4O_7$
$H_2O-NaBO_2$
$H_2O-NaBF_4$
H_2O-KBF_4
$H_2O-H_3BO_3$

Work is now beginning on the measurement of acti coefficients and solubilities in three-salt solutions to whether the isopiestic method can easily be extended cover such systems or whether the solubilities should calculated from two-salt data. The first system chosen this study was H_2O-NaCl-Na_2SO_4-$MgSO_4$ at 25° and Experimental work is in progress.

LIMNOGEOLOGY SECTION

The Limnogeology Section has been responsible undertaking research on the bottom sediments and pended particulate material in major Canadian Lakes their interconnecting waterways. Activities in 1971

[1] Russ. J. Inorg. Chem., *13*, 600 (1968).

er five main headings: Regional Inventory Studies, cess Studies, Special Studies, Technological Develop-it, and Contract Studies. A wide range of investigations carried out mostly in the lower Great Lakes and a ificant amount of the 1970-71 data has already been sented or submitted for publication.

ional and Inventory Studies

onnaissance Seismic Surveys

Regional seismic reflection surveys were undertaken in orgian Bay and the North Channel, and Lake St. Clair, to vide reconnaissance data on bedrock topography and distribution and thickness of Quaternary deposits. The veys were carried out jointly with the Geological Survey Canada (GSC), CCIW staff, and the Royal Ontario seum, using vessels provided by Great Lakes Institute, versity of Toronto, and the Canada Centre for Inland ters.

The cruise patterns consisted of east to west lines ced 10 km apart, with north to south and diagonal tie s. In addition to the instrument data, sediment samples e obtained at 88 stations.

The seismic data were obtained from broad-band logue recordings with a Bolt air gun as the energy rce, and a multi-element eel receiver towed at the face. A magnetic tape recorder was interfaced with the logue recorder.

North of latitude 44°52′ the exposed Precambrian ks slope into the basin. The Precambrian surface beneath cover of unconsolidated sediments is irregular and nmocky, similar to the topography of the eastern and thern nearshore areas.

The western shores of Georgian Bay expose Silurian and dovician strata which extend beneath the water level – deepest parts of the Bay are found along these western res. The Palaeozoic – Precambrian contact can be ntified on some seismic records.

Chart CHS 2201 shows two valleys in the southwestern t of the Bay; one is associated with Owen Sound, the er lies to the east of it. The valleys join at latitude °02′ and longitude 80°45′ and then continue north-rd. Where the survey lines cross these valleys, the data icate that they are underlain by bedrock valleys, and gest that the valley to the east of Owen Sound heads o the Bighead Valley, a large re-entrant into the Niagara arpment. The maximum bedrock relief in these valleys ermined so far is 100 m. The valleys are filled with consolidated sediments, with maximum thicknesses of er 50 m.

The sedimentary sequences in Georgian Bay are variable. Sands and/or sand and gravel overlie glaciolacustrine red clay at many localities. These red clays have laminations of silt suggesting varves. The sands and gravels are present in waters up to 115 m in depth. At other localities, grey, silty clay overlies the red clay; the grey sediments contain black iron sulphide bands. Till has been cored in the southern and northwestern parts of the basin.

The low-level stage of Georgian Bay, Lake Hough, can be recognized from unconformities, pollen studies, and the occurrence of peats and shallow-water plant fossils in sediments presently at great water depths. Evidence, so far, is insufficient to date it or map its shorelines.

Surveys in Lake St. Clair support earlier findings, and have confirmed the existence of generally very thin veneers of recent unconsolidated sediments.

Regional Sampling Programs – Lakes Erie, Ontario and Huron

A regional sediment sampling program, during the summer of 1971, provided 287 samples located on a 10 km square grid in Lake Erie. Initial analyses support the earlier findings reported to the IJC. An early study of the distribution of mercury in the lake's sediments showed expectedly high values at the mouth of the Detroit River. High concentrations (up to 2.7 ppm) occurred over the whole of the western basin and also in areas adjacent to Erie (2.6 ppm) and Buffalo (7.5 ppm) on the U.S.A. shore.

Studies on the sediments of Lakes Ontario and Huron have also continued, and the distribution of three major sediment units (glacial till and bedrock, glaciolacustrine clay, and post-glacial mud) have been mapped. Separate physiographic sub-basins strongly affect the accumulations of post-glacial muds, and the irregular bathymetry of northern Lake Huron is particularly notable in this respect.

More detailed studies on the composition of Lake Ontario sediments show that quartz and feldspar contents are greatest in the coarser inshore sediments while clay minerals and organic carbon are greatest in the finer offshore sediments. Illite is the dominant clay mineral with lesser amounts of chlorite and kaolinite. Textural characteristics of the sediments imply a mixing of two end-member populations, sands and clays. The resulting sediment distribution is believed to be a direct function of decreasing energy with water depth.

Studies on the mercury content of Lake Huron sediments suggest that the average is about 0.2 ppm, with anomalous highs generally less than 1 ppm. In Lake Ontario the average content is significantly higher, 0.6 ppm;

extensive areas are above 1.0 ppm and highest values (as in Lake Erie) exceed 2.0 ppm. The mercury distribution strongly reflects the influence of the Niagara River, the general mass transport eastwards along the southern shore of the lake, and possible additional inputs along the south shore.

Nearshore Sediment Inventory

This sampling program was again extended eastwards to cover the area between Presqu'ile and Main Duck Island in eastern Lake Ontario. Bedrock dominates the area east of Wicked Point, but sand covers much of Wellington Bay where its maximum thickness does not appear to exceed 5 m. Sand which appears to be derived from glacial drift (in the Presqu'ile area), is transported by eastward longshore drift, and is trapped by the Owen and Wicked Point promontories. Comparison of the present sediment distribution with that of an earlier study of Wellington Bay by Kindle in 1925, suggests that both the extent and thickness of the sand bodies may have increased.

In Lake Erie, the nearshore inventory program extended sampling westwards from Mohawk Point to Peacock Point; four bottom types were identified: bedrock, till, glaciolacustrine sediments, and recent muds. Bedrock outcrops inshore and on an offshore ridge between Hoover and Peacock Points. Glaciolacustrine sediments, capped with a thin lag sand, generally occupy the intermediate and outward parts of the zone. Till and associated lag deposits comprise most of the zone east of Port Maitland and isolated exposures occur elsewhere throughout the zone. Recent muds overlie the glaciolacustrine sediments in deep water and also comprise the fluvial deposits at the mouth of the Grand River. The shoreline generally intersects a low till bluff with bedrock exposed at or near the waterline. In the vicinity of Peacock and Mohawk Points, the till bluffs exceed 10 m and are undergoing active erosion. Dunes occur at Rock House Point.

Grid Survey

The field work of this sampling survey, covering the selected areas of Niagara and Kingston (Lake Ontario), and Tobermory (Georgian Bay), was successfully completed during the year. Of prime importance has been the collection of more than 300 high quality underwater photographs for comparative analyses. Although only about 30% of the sedimentological and geochemical analyses have been completed, physiographic plots are complete and seismic interpretation is well advanced. Of particular interest has been the location, in the Kingston area, of extensive levels related to the post-Iroquois low lake Admiralty phase. Since such areas were influenced by littoral conditions they may prove to be of some interest as potential sand-source locations (probably acceptable from both the ecological and resource standpoint).

Isostatic Rebound – Lake Huron and Georgian Bay

A simple theoretical model was established wh describes the effects of isostatic crustal rebound on l level and drainage in the Huron – Georgian Bay Ba during the last 10,000 years. The model shows that the l level, and hence water volume and shoreline positic varied by several orders of magnitude when the basin differentially tilted up to the north. The earliest post-gla lake levels were extremely low (over 130 m below pres level) and drained northeastward over a succession thresholds around Manitoulin Island into Georgian Bay ultimately into the Ottawa Valley through the Nipissin Mattawa lowland. Lake levels then rose with rebound of outlet area to the Nipissing Great Lakes stage about 18 above present lake level, approximately 5,500 years a Renewed operation and subsequent erosion of the pres St. Clair River outlet caused Lake Huron to fall gradually its present position.

Some of the theoretical predictions concerning low l levels were borne out by a series of piston cores, up to 2 in length, collected from Lake Huron. Unconformit commonly indicated by thin units of sand, gravel, shells plant detritus, were revealed in the late glacial – post-gla sediment sequence at nine localities distributed through the Huron basin. Of particular significance is an extens bed of buried plant detritus indicating a previous ma environment. The detritus underlies an area of at least km^2, 17 km east of the Michigan shoreline on latit 44°30′N, where the present water depth is 59 m.

Process Studies

Nearshore Processes – Western Lake Erie

An investigation into the sediment distribution and transportation in western Lake Erie, along the Canad shore, was completed. The area of concern extended fr the Detroit River mouth, eastwards towards Wheatley. W the exception of sediment input from the Detroit Ri most source material (west of Point Pelee) is derived fr erosion of bluff materials (at a rate of about 1.5 m/a). the east side of Point Pelee, the subaqueous erosion glacial till appears to account for much of the rec sediment accumulation. Stream inputs are negligible. diment movement in the vicinity of Point Pelee appear be more complex than was previously believed and dications of reversals in longshore drift on the west sid Point Pelee were found in both textural and mineralog data. Although the causes of erosion at the tip of Po Pelee are difficult to define precisely, they appear to related to: shoreline construction, offshore dredging, persistence of high water levels.

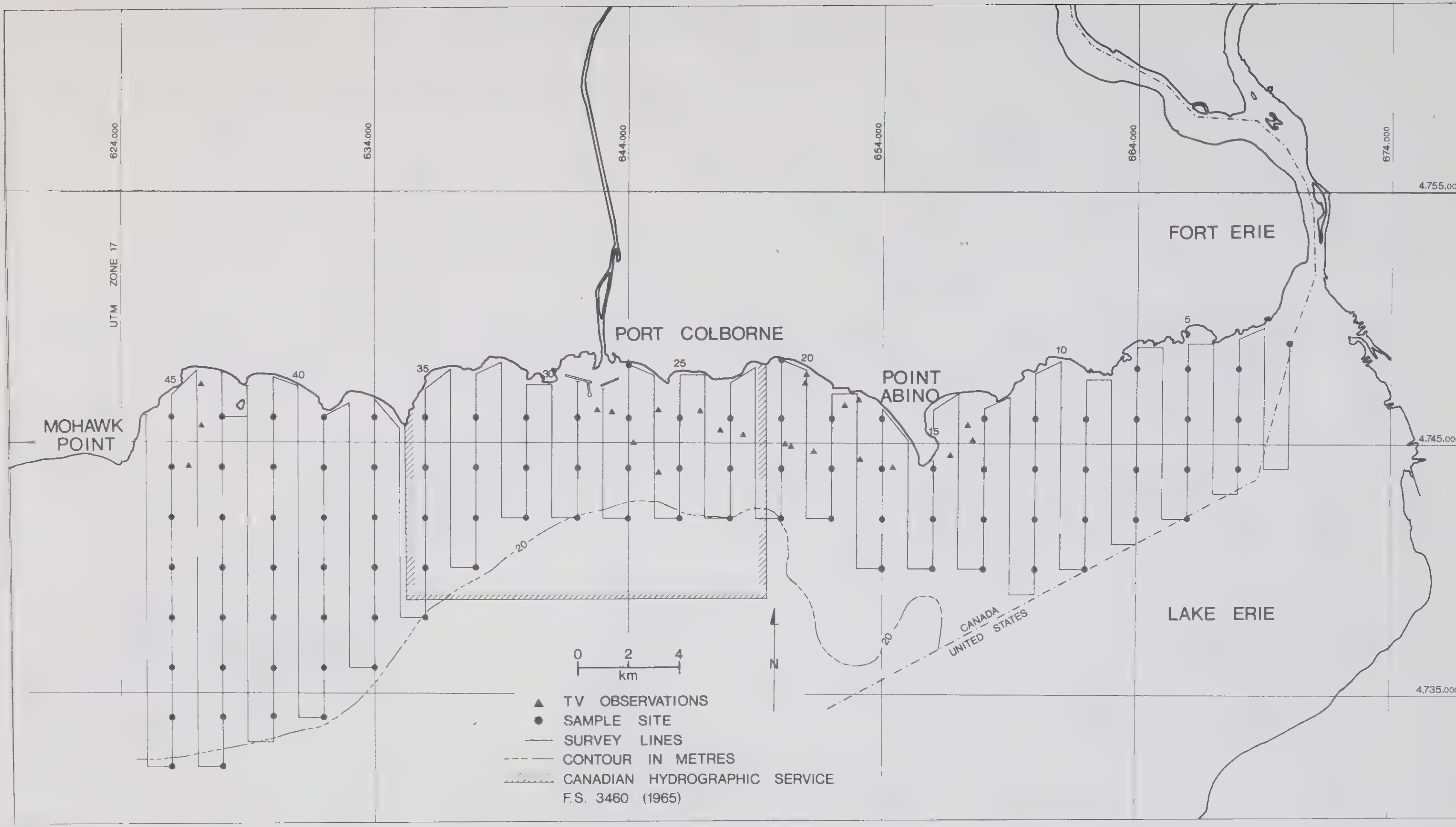


Figure 8. Survey pattern and sampling points.

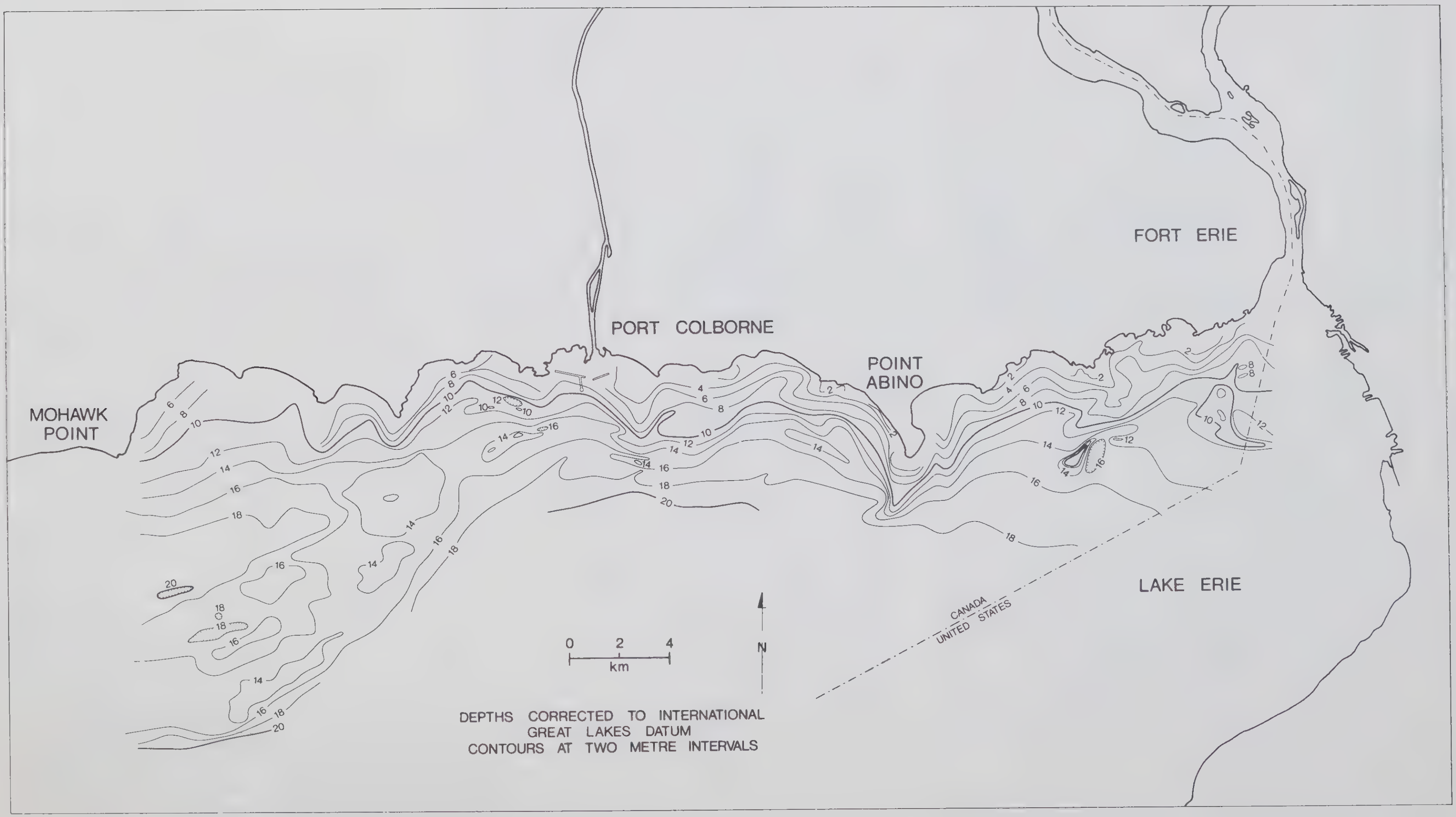


Figure 9. Nearshore bathymetry.

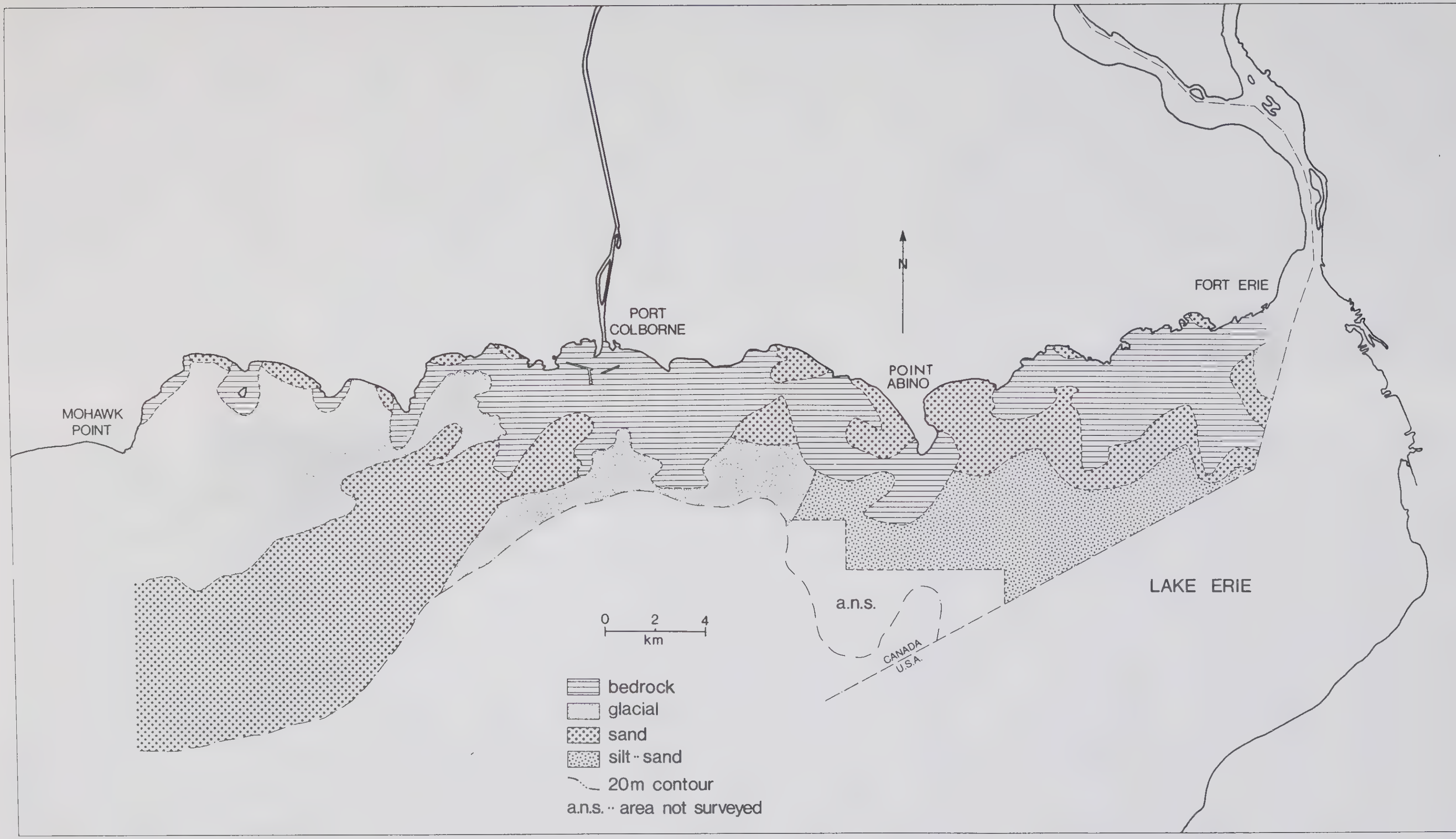


Figure 10. Bottom sediment distribution.

Related studies on sediment transport, using tracers, also reflected the variability in direction of longshore drift along the Point (frequently northerly along the southwestern part); south, east, and northward vectors were all observed. Drift rates appeared to be directly related to significant wave height and incidence, with maximum velocities of 0.3 m/s.

Monitor Sediment Survey (MOSES)

This program was initiated in March of 1971 and so far ten cruises (about one-month interval) have been completed, covering an area of some 80 km^2 at the extreme western end of Lake Ontario. Two trends in the data have been observed so far: (1) water depths appear to be deepening in the nearshore area, and shoaling offshore, and (2) major textural changes appear to be occurring at intermediate depths (12 to 24 m). These generally consist of a change in the sand/silt ratio and appear to be independent of bathymetric change. The study also involves trace element and heavy metal geochemistry, sediment bacteriology, bottom fauna, recent stratigraphy, and is supported by additional aerial reconnaissance.

Sediment Bacteriology

This study has been undertaken in conjunction with the MOSES program. The emphasis has been upon heterotrophic total counts and biotype distributions. Although total counts reduced with sediment depth (aerobes 8.2×10^7 and 2.5×10^6; anaerobes 4.9×10^5 and 8.3×10^4 – surface and 21 cm depth) the primary relationship appears to be with Eh. Sediment profiles were very similar between July and October, have less reduction in November, and very much less by December. It is not yet known if the bacterial population will increase significantly in response to the smaller reduction rate of the sediment observed in November and December.

Rates of Sedimentation

Studies have continued on the rates of modern (offshore) sedimentation in Lake Ontario estimated by determining the *Ambrosia* horizon (circa 140 years BP). From a total of 20 sediment cores located throughout the lake, the horizon appears to occur beneath 15 to 25 cm of sediment cover. The data so far suggests a uniform filling of the various sub-basins at a rate of about 2 mm/a. Because of the prevailing winds and mass transport within the lake, sedimentation is greatest in the Mexico Bay region.

Lake Sediments

(a) Carbon, Nitrogen and Phosphorus (C,N,P) Content: Mud cores from Lakes Huron, Erie, and Ontario have been measured at close intervals, for total organic matter, nitrogen and phosphorus content. The values observed from Lake Erie and Lake Ontario cores suggest an expor increase in such content from an estimated tir deposition (1900) to the present. No significant cl were observed between the 1900 level and presen surface in the Huron core. The results clearly demonst three-fold increase in organic matter, nitrogen phosphorus input into Lakes Erie and Ontario (ov natural level), but no significant change is so far obser northern Lake Huron.

(b) Forms of Nitrogen: Continuing studies have that organic nitrogen accounts for more than 95% total sediment nitrogen found in the Lake Ontari Hamilton Harbour muds; the remaining nitrogen be the fixed- and exchangeable-ammonium form. ammonium nitrogen accounted for more than 90% sediment nitrogen in the Lake Ontario glacial sedi C:N:P ratios in the surface sediments and the incre fixed-ammonium nitrogen in cores indicate tha nitrogen released by the decay of organic matter is re to the lake water at the sediment interface, while it is by the clays at a greater depth in the sediment cover.

The nitrogen content of Great Lakes humic acid the oceanic environment) is double that usually fo soils, though the humic/fulvic acid ratio is similar t reported in tundra soils (pointing to the similarity two environments).

(c) Forms of Phosphorus: Studies on sediment s from Lakes Erie and Ontario have shown that phosphate, sorbed forms of orthophosphate, and (calcium phosphate) were present at the surface. and organic forms decreased with depth in sediment apatite increased. Sorbed orthophosphate is though readily mobile and capable of returning to overlying under certain conditions (e.g., during periods of hy netic deoxygenation). Organic phosphate is mu available for regeneration to the overlying waters. A being rather insoluble, released phosphorus into s only slowly. These findings suggest a mechanism w phosphorus becomes immobilized in lake sedime seems likely, also, that any excess of phosphorus may be accumulating in Great Lakes sediments as of high phosphorus loading will ultimately be co into apatite; thus permitting little if any future regen of phosphorus under conditions of improved water

Interface cores were obtained from six locat Lake Erie, on a monthly basis between May and No New techniques which allow precise subsampli progressive electrode emersion in core material ar used. The pH values averaged 7.0 to 7.3 and showe or no variation with depth, location, or time of sa

lues of the top 0.5 cm of sediment reflected that of verlying water. In cores where recent mixing of the e layers appeared to extend below the 2 cm depth, ecline was more gradual. The results, which compare visual observations, suggest that surface sediment tion does not extend more than about 2.0 cm unless diment is subject to disturbance.

) Chlorophyll Studies: Detailed studies were initiated e distribution of chlorophylls in the surface sediments e Great Lakes, together with studies on organic esis. In this first year of the program, analytical iques have been significantly improved; sensitivity to phyll *a*, using thin layer fluorescence scanning in tance mode, is now 0.1 ng (± 10%). This is about two s of magnitude better than the elution and spectro-metry technique previously used. These studies form of an MSc course at Queens University, Kingston, has also involved a sediment-water interface sampling am in Lake Opinicon and Little Round Lake (north of ton).

al Studies

L – Compilation

map showing the distribution of surficial deposits tocene geology) in the Lake Ontario drainage basin, ding the sediments beneath Lake Ontario, is being red for publication to a scale of 1:500,000. The l history and evolution of Lake Ontario will be ated in a series of sketch map inserts. Because further data were required in some areas of the United States Canadian portions of the drainage basin, the anti-d completion date for the map-draft is now late 1972 uary 1973.

ield mapping is being conducted in Canada by the gical Survey of Canada (GSC), in the United States by use University for New York State Geological Survey. CCIW are compiling data for Lake Ontario and the is preparing the sketch maps of Ontario-basin glacial y.

gan Task 121

y the end of 1971 the sample and data collecting s of the Okanagan study were almost complete, and tion of data and compilation of results were at an ced stage. A number of interesting characteristics have noted with regard to the lake system. A 50-foot stand, asized by the presence of erosional features and nt deposits, has confirmed the existence of a former lake level in both Okanagan and Skaha Lakes. nulations of very considerable thicknesses of uncon-ted deposits have been recorded from seismic studies, well in excess of 1,000 feet thick. A submerged drumlinoid feature has been observed off Squally Point, on the floor of Lake Okanagan.

From both the sedimentological-bathymetric and geochemical aspects, each of the major lakes can be divided into a number of sub-basins. It appears that these are frequently quite distinct, and may differ markedly even within the same lake. Particle size and trace element analyses are not yet complete; however, mercury distributions show interesting trends. Mercury values are high in Wood Lake, marginally lower in Kalamalka Lake, and in Lake Okanagan (above Vernon). Below Vernon values remain low, but in Osoyoos values again rise significantly. Ash bands have been identified in cores from both Kalamalka and Osoyoos Lakes and will be used for dating and estimating accumulation rates. Interpretation is not yet complete.

Analyses of total amounts and forms of phosphorus from lakes in the Okanagan Valley indicate no relation between phosphorus content in sediments and the degree of eutrophication of the lake. In Lake Okanagan, total phosphorus of surface sediments varied from 800 to over 3,000 ppm and tended to increase towards the centre of the lake. Values for Skaha were generally lower (200 to 1,200 ppm) although this lake is more eutrophic. These findings indicate that the gross chemical and mineralogical characteristics of the sediment, such as the amount of fine clay-sized material, may play a greater role in determining the level of phosphorus that accumulates in the surface sediments, than does the concentration of phosphorus in the overlying water.

Bell-Nottaway Study

In response to a request for assistance to study mercury levels in sediments of the Bell-Nottaway River System (N.W. Quebec), the area staff undertook sampling programs in early September and October. Sampling was undertaken from an 18-foot (trailer mounted) launch, and from a float plane. Twenty-three sampling locations were established in eight lake areas of the river system. Results, to date, indicate that total mercury content in the sampled sediments is extremely low; however, further appraisals of the data are currently being undertaken and final results are not yet available.

Hudson Bay and Mackenzie Study

GSC staff, based at CCIW, were involved in a reconnaissance survey of Hudson Bay from the end of July to the beginning of October. 2,500 line miles were covered using echo sounding, seismic, and side scanning equipment. Lakes Division staff provided limited support for a reconnaissance survey program in the lower Mackenzie delta, under the

direction of GSC staff during the period June 15 to August 7, 1971. Detailed reports are provided in the Geological Survey of Canada Report of Activities 72-1A.

St. Clair and Detroit River System Studies

As part of a co-operative federal-provincial study on mercury pollution in the interconnecting channels between Lake Huron and Lake Erie, Section staff participated in a limited sampling program in Lake St. Clair and the Detroit River during May. The object of the survey was to define 'natural' mercury background concentrations within the general trends and to differentiate pollutant mercury, its transport paths and possible quantities. Reports on this study are presently confidential, pending judicial proceedings by the Ontario Government.

Chironomid Studies

Palaeoecological studies on chironomid forms derived from sediment cores taken at selected sites in the Bay of Quinte and the Long Reach (Prince Edward County-Lake Ontario), as part of a doctoral study by a CCIW staff member at the University of Manitoba, are showing signs that the environmental conditions in the area have changed significantly under the impact of human development. Core

Figure 11. Survey vessel "North Star of Herschel Island", Mackenzie Delta Program.

samples in the shallower areas of the bay have y remains of mixed populations, indicative of inpu multiple sources, and probable sediment reworking. deeper core sites, however, significant population c strongly suggest a trend of increasingly eutroph otherwise degraded conditions. Present studies a phasizing the statistical trends of population variatio

Palynological Studies

Pollen studies of lake sediments are providing information about the transport and diagenesis of r sediment. In addition, studies of fossil pollen are lea the establishment of horizon markers and chro subdivisions of the complete late glacial and post sediment column. Investigations have been con under a GSC contract at the Royal Ontario M Toronto. During the latter half of 1971, addition nological studies have continued under the supervi an NRC-GSC post-doctoral fellow.

Studies in Lakes Ontario, Erie, and in adjacen lake basins have established that the highest poll centrations occur in the basinal, silty clay facies c Ontario's surface sediments (top cm); the lowe centrations are associated with coarser sediments inshore zone. Local percentage trends suggest tha pollen in the sediments is delivered to the lake by ri stream transport.

Stratigraphic pollen analyses show that the muds and underlying glaciolacustrine clays of Ontario, Erie, and Georgian Bay do contain pollen al often degraded. Distinctive pollen assemblages ha divided into eight zones. The uppermost zones terized by high ragweed, grass, and other pollen ty relatively recent, generally less than 150 years o provide extremely valuable chronologic horizons fo mining rates of sedimentation.

Physiographic Charting

A long term program has been initiated jointly w Inland Waters Branch Drafting Office, Ottawa, to un preparation of a series of physiographic charts of th Lakes. The first compilation, covering Lake On nearing completion, and is to be published in t release at the 24th International Geological Con Montreal (August 1972). The charts will be colou will carry information about general sediment distri and both raised and submerged shorelines.

A second chart, covering a much smaller Georgian Bay, north of the Bruce Peninsula, is al compiled and hopefully will be available for conjunction with Ontario's first underwater provinc

Tobermory.

nological Development

puter Stat-Store Programs

Progress was made in the development of computer and stical techniques for the reduction of Great Lakes ogic data. Data display programs utilizing both COMP and Benson-Lehnner plotters are now in ation for presenting X-Y spatial data. Work was ated on establishing a storage and retrieval facility at W for lake sediment data. The SAFRAS system, loped at the University of Western Ontario, was chosen this purpose and with the co-operation of the Canadian tre for Geoscience Data, three files corresponding to board, physical laboratory, and analytical laboratory , were initiated. Final testing, including the entry and ctive retrieval of a test file, is scheduled for January 2.

graph 5000 Analyser – Appraisal

The results of a continuing appraisal of the automated icle sizer, Micromeritics Corps., recently brought into in the Sedimentology Laboratory of the Section at W, indicate that it overcomes difficulties encountered in tte analysis for grain-size analysis in the silt-clay size e and still provides acceptable values.

tinuous Seismic Profiler

As part of a continuing development of techniques and ipment to provide high resolution, continuous seismic iling, work is being done with HUNTEC (70) Ltd. of onto on the replay of unfiltered signals recorded chronously on an on-line four-channel magnetic tape rder. Original data is recorded on a wet paper recorder frequently, due to excessive energy levels, shallow er, or extraneous noise, resolution of early returns has n masked or lost. Later replay and selective filtering of r quality sections of profile have been made possible by of the mag-tape system. In most cases, improvement has n effected. These studies have shown the need to elop hydrophone arrays of improved sensitivity (but less eptible to extraneous reflections), the need to control er the energy level of acoustic and seismic sources, and need to be able to control the frequency of the energy trum in relation to sediment type.

tract Studies

ms of Mercury in Sediment

This study is currently being pursued under a contract h Barringer Research Ltd., Toronto. The purpose of this ject is to develop a realistic method of distinguishing ween, or where possible identify, the different mercury compounds which commonly occur, particularly in the Great Lake sediments.

It appears from analysis of other elements that the mercury is most probably not present as an individual compound but is far more likely to occur as a complex with iron oxide, clay minerals, or organic matter. The work should be completed by March of 1972. Fifty to sixty samples representing a variation of cross-section conditions from Lake Huron, Lake St. Clair, Lake Ontario, and Lake Erie will be run in conjunction with further known samples.

Lake Superior Survey

A contract with the Department of Geology, Lakehead University, was extended from 1970 to 1971 under similar terms, for the survey of nearshore and bottom sediment types in Lake Superior. Studies were concentrated in the nearshore region, in Black Bay, and in Nipigon Bay during the early part of the program, but later, extensive support by the MV MARTIN KARLSEN enabled samples and cores to be taken for deep water coverage (to the international boundary) between Thunder Bay and Marathon.

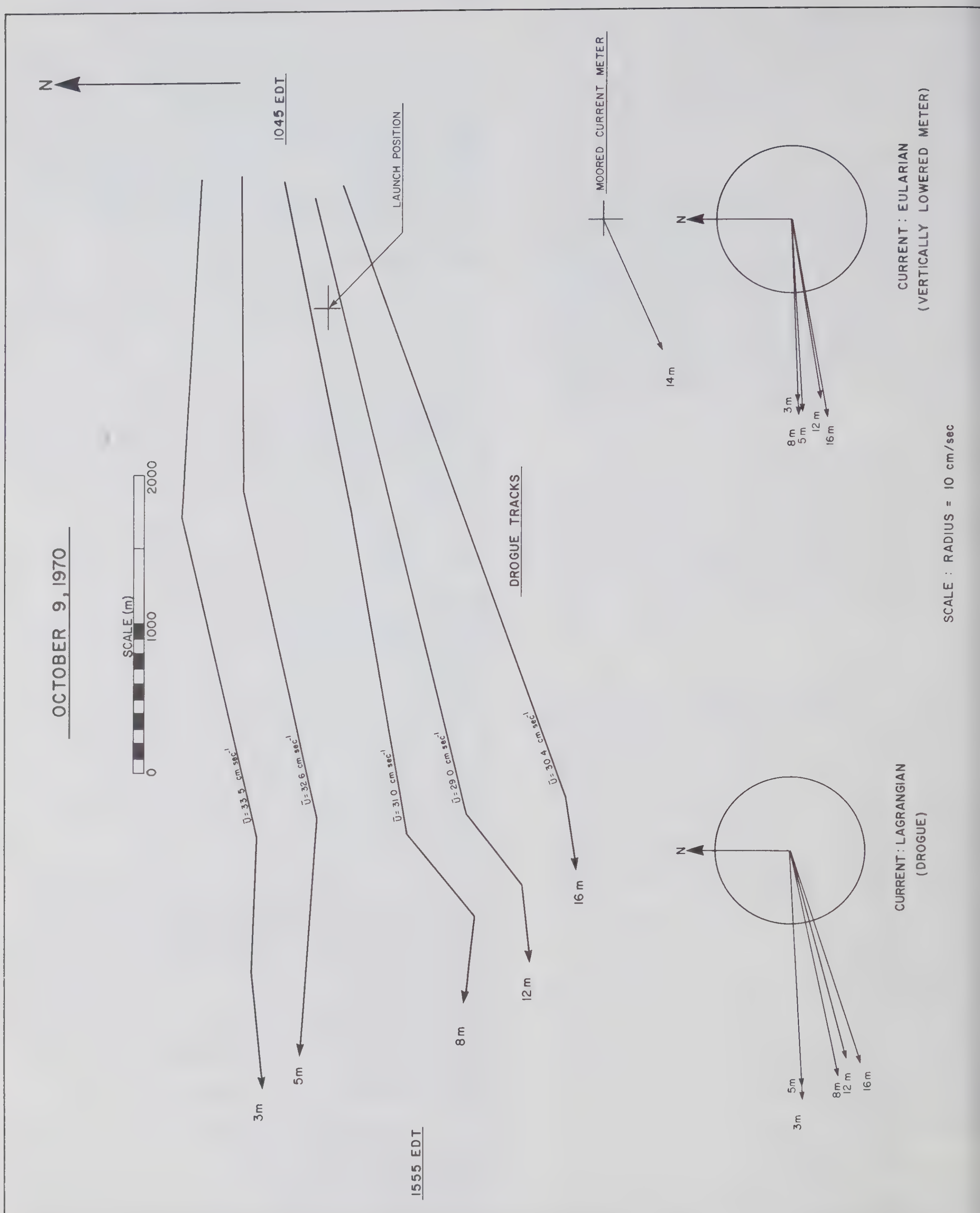
The sampling program has confirmed the presence of unconsolidated sediment cover over most of the lake bed surveyed; the only notable exception being in the area around the Lake Superior shoal where bedrock is exposed. Recent sediment reaches a maximum thickness of about 6 m to the south of the Black Bay Peninsula. However, the presence of exposed red-Valders varved clays over extensive areas of the lake floor in eastern and central parts of the 1971 survey area suggests non-deposition or even erosional conditions. Scour channels (apparently sub-lacustrine in origin) developed in recent sediments south of the Nipigon Bay outlets suggest that outflow from the Nipigon region may extend some distance southwards into the main lake basin. This observation is further supported by the fact that sediment Eh, and some heavy metal distributions show a degree of N-S linearity in the same general area.

There appears to be no evidence of significant industrial or urban pollution in the main lake areas, with the exception of some anomalous values noted close to Marathon. Evidence of environmental degradation appears to be most noticeable in the sediments of Thunder Bay.

Survey of Dredging, Disposal and Burial Techniques

As a follow-up to studies on the distribution of heavy metals (in particular, mercury) in lake bottom sediments, and to provide a better insight into the problems of removal or disposal of dredged materials, a contract has been established with H.G. Acres, Niagara Falls, Ontario.

In particular, the problem of removal or burial of



OCTOBER 9, 1970
N
SCALE (m)
0
1000
2000
1045 EDT
LAUNCH POSITION
MOORED CURRENT METER
14 m
DROGUE TRACKS
$\bar{U}$ = 33.5 cm sec^{-1}
$\bar{U}$ = 32.6 cm sec^{-1}
$\bar{U}$ = 31.0 cm sec^{-1}
$\bar{U}$ = 29.0 cm sec^{-1}
$\bar{U}$ = 30.4 cm sec^{-1}
3m
5m
8m
12m
16 m
1555 EDT
CURRENT : EULARIAN
(VERTICALLY LOWERED METER)
3m
5m
8m
12 m
16m
CURRENT: LAGRANGIAN
(DROGUE)
3m
5m
8m
12 m
16m
SCALE : RADIUS = 10 cm/sec

ury contaminated sediments in the Great Lakes is l, and suggestions for dealing with this existing tion are requested together with an evaluation of the and effectiveness of various methods.

The ecological impacts of the various techniques for val or burial are also to be considered, insofar as case ry and published information is available. The contract be completed in June 1972.

PHYSICAL LIMNOLOGY

The Physical Limnology Section is responsible for cts of lake behavior which are related to physics. raphically, the major effort has been in physical and idisciplinary projects in the lower Great Lakes, es- lly Lake Ontario. A substantial portion of this work een in connection with preparations for the 1972/3 national Field Year on the Great Lakes (IFYGL). cipation in a joint federal-provincial (British Columbia) y of the Okanagan Basin was continued. An expansion he Section's involvement in research of small lakes rred with the permanent location of two staff at the hwater Institute, Winnipeg.

Progress achieved was in some of the basic physical esses, in the construction of mathematical models, and ajor developmental phases of future investigations of processes. These are reported separately. A summary pplied and lake climatology programs follows.

arch on Physical Processes

Diffusion and transport in the nearshore zone of large s is of substantial importance in studies of movements ollutants. Of particular interest is the case where a nocline is interposed between an outfall and the free ce. Results of deep water diffusion studies in the shore have shown some striking peculiarities as compared to ce layer diffusion studies. Vertical diffusion appears to uite regular, similar to molecular diffusion, and the tive diffusivity is of the order of 1 $cm^2 s^{-1}$. Vertical sion is controlled by very small scale motions; horizon- liffusion, on the other hand, was very irregular and s to be a consequence of internal wave motions. These ires of diffusion may be attributed to the current ture in the shore zone, where a fairly well marked an motion" occurs on which large scale unsteady flow tures are superimposed.

Accurate measurements of *current velocities* are es- ial to studies of coastal processes. The Lagrangian and rian types of measurements were compared by using ues and both moored and deck read-out current meters. The two techniques give equivalent values of the mean flow velocity within the limits of experimental accuracy (see Figure 12). Coastal currents were generally shorebound and flowed 'up' or 'down' the shore for a few days and reversals occurred mainly in response to changes in winds. In addition to such bi-modal flow characteristics, occasional stagnation periods were observed, during which negligible current velocities persisted for a few days. These data, along with meteorological data measured simultaneously will provide the basis for establishing a climatology of coastal currents essential for site evaluation and planning effluent outlets and municipal water intakes.

Preparations have been made to use the observed coastal current data to verify currents computed by numerical-hydrodynamical models based on observed wind data. It is hoped that nearshore currents will be predictable from numerical models using observed wind field data.

In a separate study, current meter records obtained in 1971 from Main Channel, between Lake Huron and Georgian Bay, have shown strong evidence of *semi-diurnal tidal motion.* Corresponding water level changes of 5 cm, are identifiable in water level records from several places in Georgian Bay. This appears to be a near-resonance phenomenon, as the fundamental period of oscillation of the Lake Huron – Main Channel – Georgian Bay system is about 12 hours, close to those of some of the astronomical forces. The implication of tidal motion in the Main Channel is that, in the absence of net flow, the exchange of water between Lake Huron and Georgian Bay would be wholly predictable. The results of a detailed investigation of these findings will be reported in 1972.

Vertical circulations, including entrainment and upwelling, are important in connection with the interactions between stratified layers in lakes. Thermal data on several morphologically different lakes have been compiled in order to test the applicability of the one-dimensional theory of turbulent entrainment to the growth of epilimnion volumes in stratified lakes. The surface areas of the lakes varied from 0.04 km^2 (Lake 304, Western Ontario) to 31.5 $10^3 km^2$ (Lake Baikal, USSR). The test results suggest that stratified lakes achieve a balance whereby the growth of volume of the epilimnion (entrainment) is correlated with the mean stability over the period of growth. The mean depth of a lake appears to be the single most important morphological parameter governing the magnitude of entrainment (Figure 13).

The importance of entrainment has been demonstrated in Woods Lake, a small eutrophic lake in British Columbia. Major increases in chlorophyll *a* correlated well with episodes of entrainment during 1971.

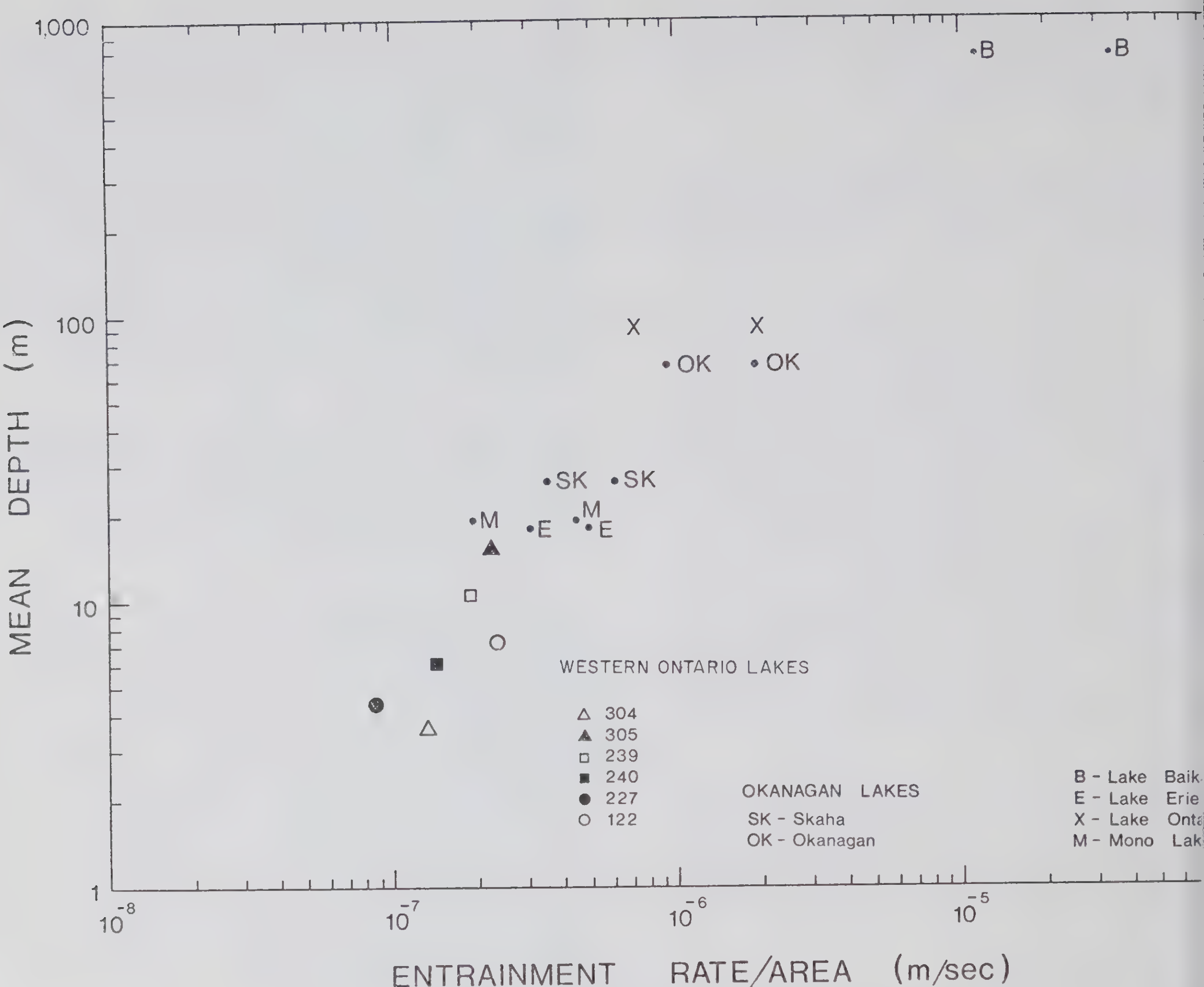


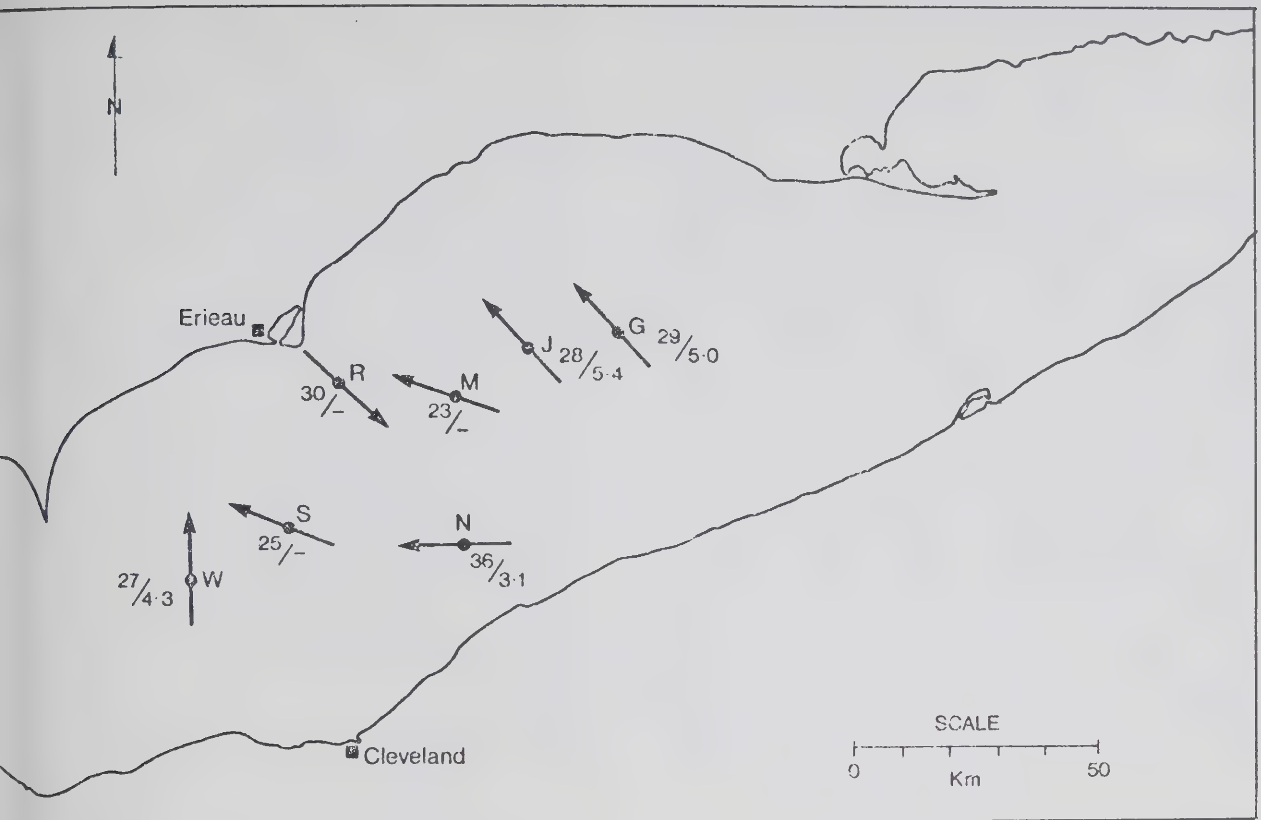
Figure 13. Relationship between entrainment rate and mean lake depth.

The study has stimulated further interest since entrainment plays a significant role in budget calculations of heat and chemicals in lakes. The circulation of hypolimnion water in Lake Erie Central Basin has been of particular interest in view of the findings of Project Hypolimnion. Analysis of current meter data from moorings established from 14 July to 3 September, 1970, showed dominant currents toward the Canadian coast (Figure 14). Upwelling along the Canadian shore appears to account for a significant portion of this net hypolimnion flow.

Other episodes of upwelling have been studied in Lake Ontario. The key result from a descriptive point of view lies in the fact that many of the upwelling regions in Lake Erie and Lake Ontario are extremely narrow, often extending no more than 3 or 4 km from shore. These regions may be missed by normal monitoring programs. Upwelling in these lakes is generally correlated with the alongshore component of the wind.

In a program devoted entirely to *processes in lakes*, lakewide circulation was measured in a small la hectares) in the Experimental Lakes Area (ELA) Freshwater Institute, near Kenora, Ontario. Tempe and Eulerian velocities were recorded continually instrument tower near the center of the lake. Lagr velocities were obtained on 20 separate occasic tracking drogues with shore based radar. Lakewide tions in diffusion characteristics were examined b sequential, aerial photography of an array of five nuous point-source dye plumes. Dye plumes near the of the lake show marked similarity with plumes pre photographed in the Great Lakes. Nearshore plume large spatial and temporal variance in both relati absolute diffusion characteristics. Analyses of the d continue.

The *exchanges of energy between the atmosphe lakes* continue to receive a high level of attention a



re 14. Dominant currents in the hypolimnion during the period 14 July through 3 September, 1970. The arrows represent the dominant direction toward which the currents are moving. The number to the left of each slash represents the percentage frequency of occurrence of all currents within ±30° of the dominant direction. The number after the slash is the average speed in cm/sec of the currents associated with the dominant direction.

se of their fundamental importance to thermal and nic processes. During 1971, direct measurements of y fluxes were made by the Eddy Correlation tech- using triaxial hot film anemometers, Lyman α ption hygrometer, and fine wire resistance thermo- s in Lake Ontario, near the Niagara Bar.

xteen periods of observations, each lasting forty es, were recorded under a wide range of atmospheric ea-state conditions. Mean vertical gradients of wind, rature, and water vapor were measured throughout eriod giving a total of about six weeks of data. In on, the Thornthwaite Unit Parcel Momentum Flux- was operated for a total of 170 hours to provide ation of that sensor system. Many of the data periods ded with periods of observation by Atmospheric onment Service and Atlantic Oceanographic Labora- groups and two periods of coincident observations obtained with a research aircraft from the National autical Establishment, Ottawa.

he early results indicate that sensible heat transfer is one-tenth of the latent heat transfer during the autumn period. A Bowen Ratio of 0.1 to 0.2 was observed during periods processed to date. All periods have been thermally unstable. Values of computed surface drag coefficient have indicated that the previously used value of 1.3×10^{-3} is likely valid. Range and variation of values will be determined after all data are analyzed.

The *modeling* program, which relies upon updated input from studies such as described above, exhibited substantial progress during 1971. Efforts were specifically directed toward the development of models which take into account the physical characteristics and stratification of Lake Ontario for the broad purpose of examining general circulation characteristics with some specific applications in mind, such as transport of pollutants in the main body of the lake, and dispersal of effluents nearshore. (Figure 15).

A summer model, which is presently employed in studies of the lake circulation under stratified conditions, consists of four layers. These layers are separated by rigid horizontal levels positioned at depths of 10, 25, and 50

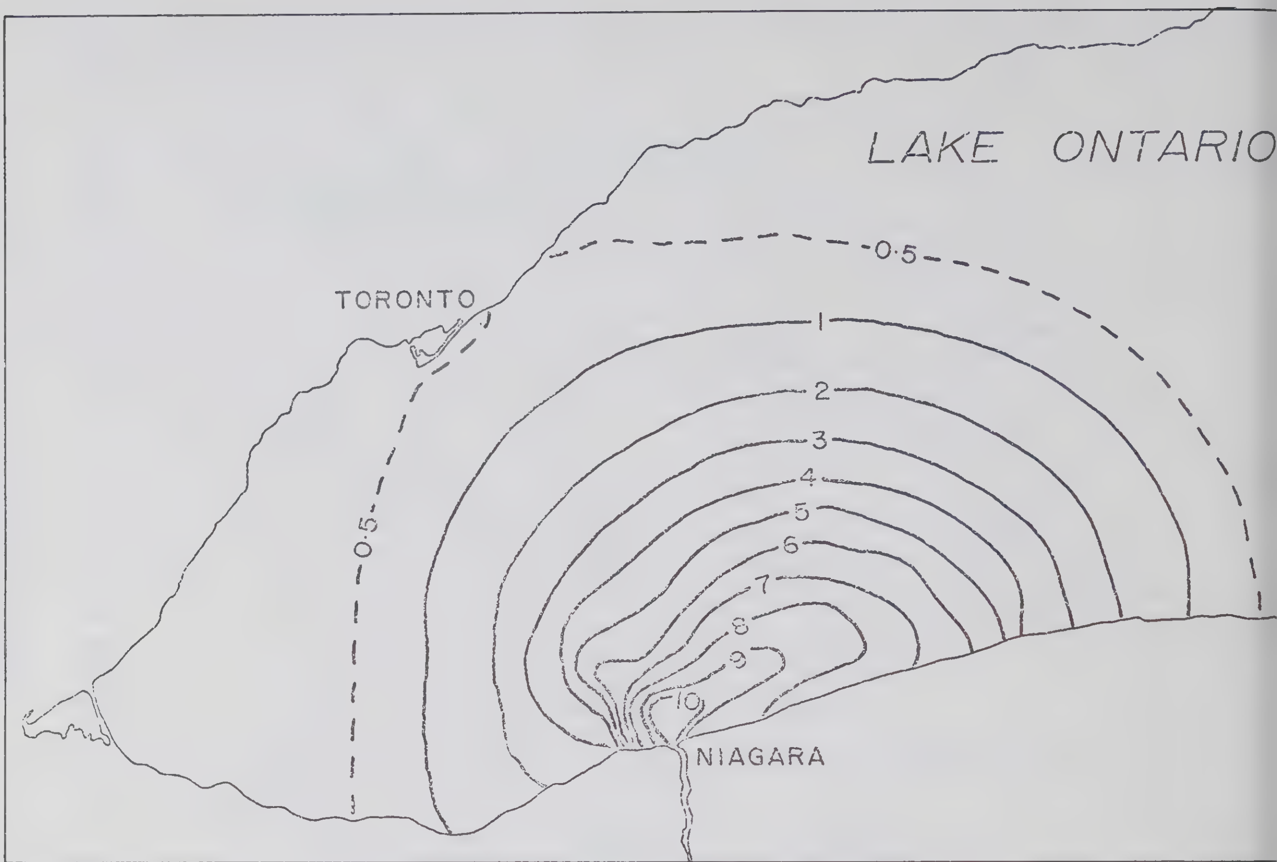


Figure 15. Advection and diffusion of a pollutant from the Niagara River as computed with a homogeneous model (hydraulic flow, no

metres, respectively. This means that the lowest layer is essentially homogeneous, whereas the stratification cycle is to be simulated by the upper three layers.

Preparations are underway for an extensive verification program to evaluate the performance of both the multi-layer model and the previously developed homogeneous models during IFYGL.

Also in the framework of the numerical modelling program, a meeting, attended by most members of the Great Lakes scientific community in this field, was convened by the Centre under the title "Workshop on the Numerical-Dynamical Modelling of the Great Lakes", August 23-24, 1971. Communication was improved and future annual meetings are anticipated.

Studies of the behaviour of *oil* in the lake environment, though not as directly related to the above programs, have been conducted in this Section. Progress has been made in evaluating the effects of oil quality and environmental factors on mousse formation and dispersion of oil in the water. This study is expected to provide us with the means of predicting oil behaviour in oil-spill incidents.

An experimental oil-containment boom was structed and tested in Burlington Bay. While the oil-fil plastic material was deteriorated by sunlight, the structure survived several weeks' exposure and some s while moored in the Bay. A critical evaluation o performance may lead to the eventual constructio heavy duty boom for the protection of the harbour.

In cooperation with the Environmental Quality dination Unit and other Sections of CCIW, a contin plan was prepared outlining CCIW's activities in spills and other hazardous materials.

Developmental Work

Many of the basic physical relationships determi one of the Great Lakes will be, generally, applicable of the Great Lakes. Consequently, a great deal of effo been spent by CCIW in preparation for IFYGL, in or make the most of this extensive study of Lake Ontari

In the water movements category, a substantial was devoted in 1971 to the design, development, an testing of reliable *dye injection and sampling syste* particular, a new mooring arrangement for the dy

ure 16) was developed and field tested successfully. To rove the reliability of the dye injection system on board dye raft automatic switching circuits were installed in r to activate a second dye injection system in the event ailure of the main dye injection system. To ensure an terrupted power supply, a diesel generating power t was permanently installed on the dye raft. With these or modifications and extensive field testing, a sound and ble dye injection system capable of generating point-ce plumes, line-source plumes, and instantaneous hes at any specified depth, is now available for usion studies during the 1972 IFYGL.

Common to the water movements' interests and those he energy balance and boundary layer categories of GL is the *CCIW buoy system.* The current meter, water perature, and surface meteorological components all erwent final developmental work and field testing. parisons of all components with those of the U.S. em (Texas Instruments system, prepared for NOAA) place in Lake Ontario during the autumn. On 8 ember, a current meter mooring was established about niles off Rochester, N.Y., close to a U.S.A. mooring. r current and temperature data were obtained from CCIW current meters during the first 28 days, and, a four-day gap, from two meters during the next 27 . Comparison of these data with those obtained ltaneously by the U.S.A. system is underway. Prelimi- assessments indicate more than 90% return of data the CCIW meters.

Field deployment of the meteorological components of buoy system had three objectives:

1) operational experience to assess equipment en-nce and to provide experimental data for development ata management and processing techniques.

2) to provide field measurements of meteorological

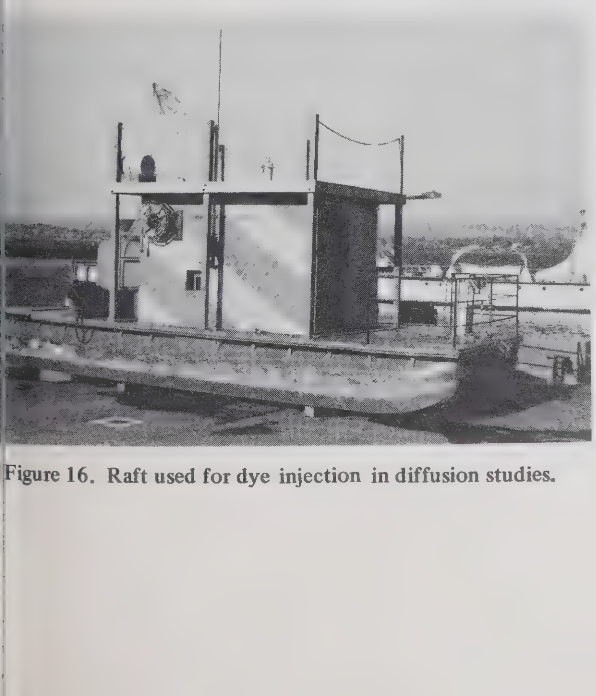


Figure 16. Raft used for dye injection in diffusion studies.

variables over western Lake Ontario for other continuing studies;

(3) to provide for comparison of the system with the U.S.A. system.

Three systems were moored in western Lake Ontario on 19 April and through 8 October, operated in a manner similar to that planned for IFYGL, giving about a 90% return of valid data. A fourth system was moored off Rochester. The three station network in western Lake Ontario provided over 10,000 hours of information on the over-lake meteorological fields. This is the longest and most complete set of measurements of these variables which has been obtained over the actual lake surface. The data have been used to provide realistic wind stress input to numerical lake circulation models and will be included in computations of energy fluxes in development of IFYGL data processing methods. Several weeks of coincident observations with the U.S.A. system has provided data which will serve to evaluate biases which may exist between the two systems and which can be used to make adjustments to planned programs of IFYGL. These data have been interchanged with agencies of the U.S.A. and some preliminary evaluation has been completed.

Also in preparation for the boundary layer aspects of IFYGL, a program of *direct measurement of fluxes of momentum, latent, and sensible heat* was carried out over Lake Ontario at a site 3 miles from Niagara on-the-Lake during September and October 1971 in cooperation with scientists from the Atmospheric Environment Service (AES), the Atlantic Oceanographic Laboratory (AOL), and the National Aeronautical Establishment (NAE).

Measurements were made by instrumentation supported on three bottom-mounted towers with recording and other logistic support housed on a barge anchored nearby.

A major component of the Energy Balance program is the *heat storage term.* Since 1968, CCIW has been developing instrumentation and techniques appropriate to the detailed description of Lake Ontario's thermal regimes. In 1971, an effort was concentrated on improving both instruments and techniques in preparation for IFYGL. This work entailed:

(1) Improvements to the towed thermistor array system comprising a better design for the thermistors, shock absorbing towing gear, more stable electronics, and more efficient calibration and operating procedures.

(2) Acquisition and commissioning of a Bedford Batfish system (a diving towed body which may be controlled electrically from the towing vessel). The output from this system in its undulating mode is equivalent to a

vertical temperature profile from the surface to a preset maximum depth every 1000 metres of steaming at speeds from 4 to 14 knots.

(3) Improvements to the technique of collecting and processing temperature data using the standard ships EBT (electronic bathythermograph). A theoretical study of the influence of the ship's drifting motion on the measured temperature profile suggested that non-negligible error could result from the smooth displacement of the isotherms due to flow under the hull of the ship. Experiment confirmed the theory, thus, procedures were developed to minimize the errors.

(4) Development, procurement, and testing of a moored, autonomous temperature profiling system. Four of these instruments will be employed in the IFYGL. Each system is capable of sampling up to 18 thermistors arranged initially in an array through 100 m of water and can operate unattended for up to 6 weeks at a time.

(5) Development and improvement of methods for reducing and displaying data from the instruments mentioned above. By April, 1972, the emphasis of this project will switch from instrumentation development to measurement and interpretation. An ambitious field program is planned for 1972 with analyses extending into 1973. It is anticipated that the instruments will prove valuable to many experiments in the future.

A series of *shore stations* around Lake Ontario to measure near shore surface and near bottom temperatures is being set up in conjunction with shore meteorological sites of the Atmospheric Environment Service and water level sites of the Water Survey of Canada. The observations will be used during the International Field Year on the Great Lakes and, over the long term, to correlate the variation of the temperatures at the shore sites with the heat content of the lake. Initial installations were made during 1971 at Oshawa, Cobourg, Pt. Petre and Kingston.

Applied Studies and Climatology

In a joint Canada – Province of British Columbia study of the *Okanagan* system, the Physical Limnology Section accepted responsibility for data collection and interpretation of physical factors relevant to this large water quality and quantity study.

Field work, including 6 monitor cruises on Lakes Okanagan, Osoyoos, Skaha, Woods, and Kalamalka, was completed in October, 1971. Comparative studies of each lake revealed:

(1) Woods Lake – had a very slow rate of warming of deep water – only slightly larger than the two very lakes.

(2) Woods Lake – the most eutrophic of the lake severe algal blooms that best correlate with high ra mixing entrainment between hypolimnion and epilir water.

(3) There has been a noticeable decrease in transparency in Lakes Woods and Kalamalka over the years. Transparency data for other lakes in the bas inclusive on this matter.

In addition, experiments to study diffusic Okanagan River water into Lake Skaha were perforn conditions of weak stratification (May) and strongly fied conditions (September). The portions of the which were most influenced by the river discharge, ar governing conditions, were clearly revealed. Repor general program and the special diffusion study w available by June, 1972.

During 1971, a follow-up study to the previous report by H. G. Acres Company on predicted *th loading* of the Great Lakes was performed to asse physical consequences of thermal inputs.

Periodic surveys of surface temperature in the th effluent of two local electric generating stations terminated in May, 1971. A total of 13 sets of su isotherms (Figure 17, for example) was obtained duri measurement program which commenced in Septe 1970. Much additional data spanning a two-year per one site have been provided by Ontario Hydro. Calcul based on this data show that an average of less than the waste heat is transferred directly to the atmos within the 1°C "excess" isotherms. The tempe decrease within a thermal effluent is predominantly a of mixing of the effluent with ambient lake water.

An estimate of possible physical effects of the heat load predicted in the Acres report for the year 2 almost completed.

A *current monitoring program* was initiated in 19 study the statistical properties of near shore lake curr selected locations in Lake Ontario, and establish a cli ogy of coastal currents and water temperature partic relevant for planning of municipal works. In 197 program was broadened to include measurements at sites in Lakes Erie, Huron, and Superior. The collection included 12 meter-months of current and te ature record from each of 11 current meters in w Lake Ontario; 6 meter-months from 6 meters in the e basin of Lake Erie; 12 meter-months from 3

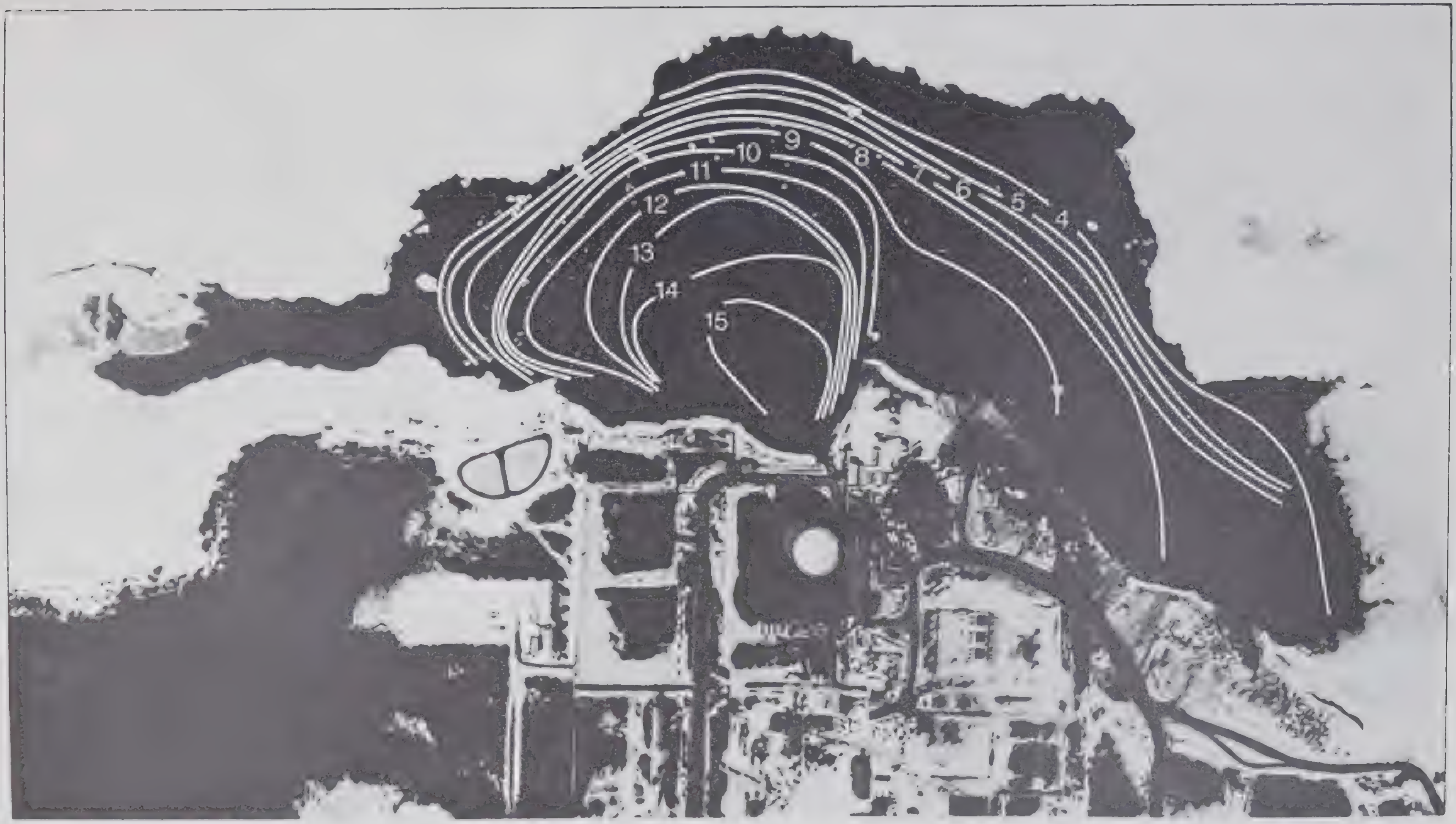


Figure 17. Surface temperatures from scanning infrared thermometer at Douglas Point, Lake Huron. Temperature contours, 1°C interval, March 2, 1971.

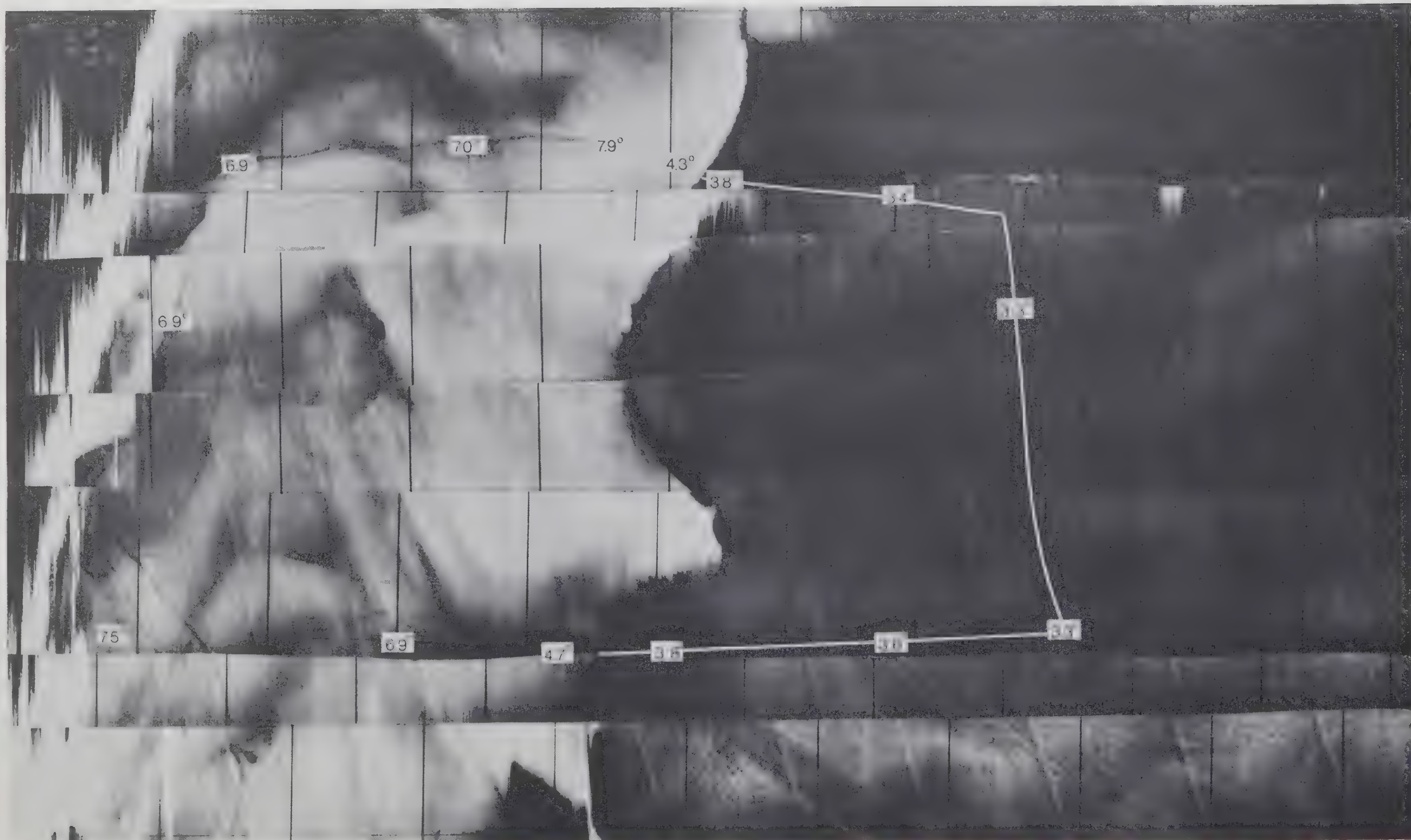


Figure 18. Infrared scanner mosaic May 23, 1971 (surface temperatures from launch data).
Infrared imagery 8-14 μ, Lake Ontario-Oshawa, Code M-2A. Temperature °C

r-months from 2 m in Lake Huron; and 2 meter-hs from a single current meter in Thunder Bay, Lake rior. The results of the measurements are to be shed in a technical report.

During 1971, a descriptive analysis program of *lake ents* became associated with this Section. The objec- are to clarify the history of nutrient conditions, to date the seasonal cycles, to provide background for the national Joint Commission upper lakes reference, and ompare the present nutrient conditions in all of the t Lakes.

study of nutrients in Lake Huron has been com-d. The Lake's plankton production is apparently ed by a shortage of phosphorus. Secchi depth trans-ncy and reactive silicate are decreasing over the years, ating a slight increase in fertilization with phosphorus. suggested that a particulate phosphorus value of /l is the lower limit for eutrophy; Lake Huron now mean particulate phosphorus value of 2.4μP/l.

tudies of nutrients in Lakes Superior, Erie, and rio are planned for 1972, and also a comparative study the Great Lakes.

general consolidation of the *remote sensing* program rred during 1971, with completion of a summary of ery obtained since the inception of the program. Field rams this year had two main objectives: continued ation of both infrared scanning and photographic iques; and conduction of surveys in support of ological studies. Table 1 contains a summary of survey ities.

tudies of the time scale of surface thermal features combined with flights to evaluate a new Daedalus line ner in the Oshawa area (see Figure 18). Both objectives met and will substantially influence IFYGL surveys.

Photographic surveys in support of other programs ded: ice surveys for the ice breaker N.B. McLean in the oit River; support of small lake dye diffusion studies Kenora (see above); and shoreline surveys for sediment es by the Limnogeology Section.

Medium and high altitude photography of Lake Ontario provided from both a NASA satellite simulation riment which benefitted from IFYGL coordination, a CCIW program coordinated by the Canada Centre for ote Sensing, which used a Canadian Forces CF-100. information on the occurrence of surface manifes-ns of internal waves has resulted and interpretation inues.

Aerial surveys of the Bay of Quinte in July and September for the purpose of detecting biolimnological factors provided new experience and will stimulate future surveys of surface algae and cladophora crops.

Two proposals for future studies using data from the forthcoming U.S. satellites ERTS-A and SKYLAB were submitted.

During 1971 preparations were made to take advantage of technological advances in the field of *data retransmission via satellites.* Arrangements were made to acquire an IRLS surface package through cooperation with NASA-LEWIS, Cleveland, and a DCP package for use with the ERTS-A satellite. Deployment of these systems aboard CCIW buoys is planned for 1972.

Data processing and display activities of this Section included the completion and submission for publication of a Summary Data Atlas of Lake Ontario (Monthly distributions of surface and bottom temperatures and dissolved oxygen). A similar atlas for Lake Erie will be completed in 1972.

In support of heat content studies, and to facilitate use of lake temperature profile data, an ambitious program to digitise all CCIW bathythermograph traces was performed. Through contract, Great Lakes Institute data was similarly treated. Editing is in progress. Closely related to this work was a project which has digitised on a 2 km grid the bathymetry of Lakes Ontario, Erie, Huron, and Superior. A general contouring program was also modified to permit production of contour charts of lake monitor data.

Surface distribution charts of temperature, wind vectors, and bathythermograph observations of Lake Ontario during cruises of 1970 were subjected to analyses to determine the spatial and temporal thermal variation over the entire year. Using a heat content program, the volume of water of the lake contained between successive isotherms was computed. These results are assembled in the form of a report showing the thermal structure and changes in heat storage between successive surveys. A similar report is being prepared for Lake Huron from observations taken in 1971 and will be completed in early 1972.

TECHNICAL OPERATIONS

Major Ships

As in 1969 and 1970, the Section used the two major vessels, C. S. S. LIMNOS and the charter vessel M. V. MARTIN KARLSEN, for scientific data collection and monitoring. The C. C. G. S. PORTE DAUPHINE, through contract arrangements with Great Lakes Institute, Univer-

TABLE 1. SUMMARY OF 1971 CCIW REMOTE SENSING SURVEYS

DATE	AIRCRAFT	SENSORS	GROUND TRUTH	LOCATION
Jan. 28–Feb. 2	Piper YTE	Photographic	Ice breaker N.B. MCLEAN	Detroit River, Lake St. Cla
March 1–9	Piper YTE	Photographic		Western Lake Ontario shor
April 14	Piper YTE	Photographic	Limnogeology	Western Lake Ontario shor
May 21–24	Aztec	Thermal Scanner PRT-5	Ship Data	Oshawa
May 29	RB 57F	Photographic	Ship Data	Lake Ontario
June 11	Piper YTE	Photographic	Limnogeology	Western Lake Ontario shor
July 27	CF 130	Photographic	Ground Party	Bay of Quinte
August 9–20	Piper Colt	Photographic	Surface instruments & launch	Kenora
August 18–19	CF 100	Thermal IR Scanner Photographic		Lake Ontario
September 10	Piper YTE	Photographic	Limnogeology	Western Lake Ontario
September 22	CF 130	Photographic	Ground Party	Bay of Quinte
September 22–24	CF 130	Thermal Scanner PRT-5	Ship Data	Oshawa
October 5–6	CF 130	Thermal Scanner PRT-5	Ship Data	Oshawa
December 1	Piper YTE	Photographic	Limnogeology	Western Lake Ontario

sity of Toronto, continued to augment the monitor program, particularly in Georgian Bay. For the first time, samples were collected from an M.O.T. icebreaker, the N. B. MCLEAN, during winter operations on Lake Erie, ranging from Port Colborne to Windsor.

C. S. S. LIMNOS carried out a large variety of highly specialized cruises including organic particle studies, pesticide surveys, seismic and geological surveys on Georgian Bay, and heat content surveys on Lake Ontario; in the latter, newly-developed temperature sensors were evaluated. LIMNOS laid and retrieved more current meters than ever before, and a unique monitor cruise was carried out off Cleveland at the beginning of July. This was to determine whether a large increase in sewage effluent (caused by a breakdown of sewage treatment facilities) could be traced across Lake Erie into Canadian waters.

M. V. MARTIN KARLSEN concentrated on monitoring the upper lakes, including twelve cruises on Lake Hu Two comprehensive geology cruises were completed – on Lake Superior for Lakehead University, and the o on Lake Huron in cooperation with Geological Surve Canada. An additional project was a dye experim involving two aircraft overflights, with Columbia Un sity.

C. C. G. S. PORTE DAUPHINE was under cont during the periods when the other major ships unavailable for monitor work. These surveys were ma carried out in Georgian Bay. Technical Operations c dinated her movements, and staff from the Great L Institute and CCIW participated in the cruises.

C. C. G. S., N. B. MCLEAN, wintered in Lake Erie ice-breaking duty and ice observations associated with

OPERATIONAL TABLE – 1971

Ship	Commenced Operations	Completed Operations	Miles Steamed	Total Active Days	Days on Survey
C.S.S. LIMNOS	March 16	December 10	11,631	193	153
M.V. MARTIN KARLSEN	March 29	December 9	22,852	190	165

.awrence Seaway Authority. Technical Operations was to use her facilities, with some modifications, for two itor cruises during February and March. Samples were 'n from over the side and through the ice at short nces from the ship. Results obtained were of great chemically, although the ship is not well suited for itor-type cruises.

ara Towers

Three scientific towers were erected near the outlet of Niagara River for *in situ* studies of physical and orological parameters. Two of these were regular -guyed towers with explosive-implanted anchors; the r was a self-mooring platform type (S.M.P.).

r Ships

The barge HANDY BOY, containing laboratories that ded a detachment from Atmospheric Environment ce, was moored for most of the field season adjacent e Niagara Towers.

The tug W. R. MORGAN, converted to a diving tender renamed C. S. L. SHARK during 1971, saw service anting underwater sensors on the north shore of Lake rio, installing the Niagara Towers, operating in support he dye barge program, and participating in the rimental oil boom installation in Burlington Bay. She also involved in a mission near Niagara-on-the-Lake a yacht and its crew were rescued.

The chartered tug M. V. LAC ERIE continued to ort the Limnogeology Section for most of the year, ling sediments in the Kingston Basin area. In mber, she sampled Western Lake Ontario for the ES program and for NTA experiments. Staffed by nical Operations personnel, she will continue NTA ling programs throughout the winter in Hamilton Bay Vestern Lake Ontario.

l Craft

echnical Operations, through Marine Sciences Branch, linated small craft assignments to all required surveys.

agan Basin Study

wo Operations personnel coordinated and carried out nain sampling program in the Okanagan Basin as part CIW's commitment to the Canada – British Columbia agan Basin Study. The operation, which lasted from uary to October, consisted of a series of monthly ical and temperature surveys on the five main lakes of Okanagan Valley. In addition, two series of dye sion experiments – one in the spring and one in the – were completed. Continuous near surface temperature data were obtained for the lakes over the entire field season, as well as two continuous temperature-depth profiles which were obtained from thermograph moorings established in predetermined positions for two of the lakes. The data obtained from these studies will be used to evaluate the existing trophic state of the lakes and the probable future conditions under a range of management alternatives.

Diving Unit

Thirteen CCIW employees successfully completed the course in basic SCUBA given by the Senior Diving Officer – three of those were from Technical Operations. This course concluded with a medical examination by an Environmental Medical Specialist. During the field season, this training was put to use in various projects, notably the Organic Particle Study. A contract diver was also employed for much of the season. With the acquisition of C. S. L. SHARK, which has proved to be a versatile addition, diving support at CCIW continues to grow.

Stores

With the spring demolition of the Quonset hut and other small storage buildings, Technical Operations began some out-of-doors areas for equipment storage. Frequent trips were made to transport men and equipment to and from field projects, and to major ships and chartered vessels, which this year spent the majority of the survey season in the Upper Lakes.

Personnel

Junior staff members attended a 210-hour course in Basic Limnology, sponsored by scientific and technical groups from CCIW. Following this course, ten staff received their Maritime Radio-Telephone Operators Certificate from D.O.T. Throughout the field season, personnel were assigned to major and minor ships and to small craft supporting shore-based studies at various locations, including Niagara-on-the-Lake, Kingsville, and the Okanagan Project. The staff were responsible for all deck observations, field equipment, coordination of vessel movements, and meteorological observations.

An electronics technician was taken on strength early in the year. He has been assigned to work in conjunction with the Physical Limnology Section installing, maintaining, and monitoring Hy-Met units on buoy and tower systems.

The Section employed nine student assistants during the height of the field season in the summer months. Most of these students were involved with chemical work on monitor cruises.

GREAT LAKES STUDIES – 1971 – MV MARTIN KARLSEN

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDA
JAN	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31	1	2	3	4	5	6
FEB	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	1	2	3	4	5	6
MAR	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29 Depart CCIW 1834 hrs.	30 Monitor Lake Ontario	31 Monitor Lake Ontario	1 Monitor Lake Ontario	2 Monitor Lake Ontario	3 CCIW Arrive 175
APR	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
	11 CCIW	12 CCIW	13 Depart CCIW 1811 hrs.	14 Monitor Lake Erie	15 Monitor Lake Erie	16 Monitor Lake Erie	17 Monito Lake Erie
	18 Arrive Sarnia 1635 hrs.	19 Depart Sarnia 1645 hrs.	20 Monitor Lake Huron	21 Monitor Lake Huron	22 Monitor Lake Huron	23 Monitor Lake Huron	24 Monito Lake Huror
	25 Monitor Lake Huron	26 Monitor Lake Huron	27 Monitor Lake Huron	28 Off Tobermory Arr.0927 Dep.0927	29 Moorings Lake Huron	30 Arrive Sarnia 0700 hrs.	1 Sarnia
MAY	2 Sarnia	3 Sarnia	4 Sarnia	5 Sarnia	6 Sarnia	7 Sarnia	8 Sarnia
	9 Sarnia	10 Sarnia	11 Sarnia	12 Sarnia	13 Sarnia	14 Sarnia	15 Sarnia
	16 Sarnia	17 Depart Sarnia 1300 hrs.	18 Monitor Lake Huron	19 Monitor Lake Huron	20 Monitor Lake Huron	21 Monitor Lake Huron	22 Monito Lake Huror
	23 Monitor Lake Huron	24 Monitor Lake Huron	25 Sault Ste.Marie Arr.0900 Dep.1705	26 Monitor Lake Superior	27 Monitor Lake Superior	28 Monitor Lake Superior	29 Monito Lake Supe
	30 Monitor Lake Superior	31 Monitor Lake Superior	1 Moorings Lake Superior	2 Thunder Bay Arrive 1505 hrs	3 Dep. Thunder Bay 1019 Coring	4 Arr. Thunder Bay 1539 Coring	5 Thunder
JUNE	6 Thunder Bay	7 Thunder Bay Depart 1000 hrs.	8 Coring Lake Superior	9 Coring Lake Superior	10 Coring Lake Superior	11 Coring Lake Superior	12 Coring Lake Supe
	13 Thunder Bay Arrive 2304 hrs.	14 In Transit	15 Dep. Tobermory 1720 hrs. Moorings	16 Arrive Sarnia 1546 hrs.	17 Sarnia	18 Sarnia	19 Sarnia
	20 Sarnia	21 Depart Sarnia 1200 hrs.	22 Monitor Lake Huron	23 Monitor Lake Huron	24 Monitor Lake Huron	25 Monitor Lake Huron	26 Monito Lake Huro
	27 Monitor Lake Huron	28 Monitor Lake Huron	29 Sault Ste.Marie Arr.0800 Dep.1855	30 Monitor Lake Superior	1 Monitor Lake Superior	2 Monitor Lake Superior	3 Monito Lake Supe
JULY	4 Monitor Lake Superior	5 Monitor Lake Superior	6 Monitor Lake Superior	7 Moorings Arr. Thunder Bay 1353	8 Thunder Bay Depart 1502 hrs.	9 Coring Lake Superior	10 Coring Lake Supe
	11 Coring Lake Superior	12 Coring Lake Superior	13 Thunder Bay Arrive 1510 hrs.	14 In Transit	15 In Transit	16 Arrive Sarnia 1657 hrs.	17 Sarnia
	18 Sarnia	19 Depart Sarnia 1335 hrs.	20 Monitor Lake Huron	21 Monitor Lake Huron	22 Monitor Lake Huron	23 Monitor Lake Huron	24 Monitor & ings L.
	25 Monitor & Moor- ings L. Huron	26 Monitor Lake Huron	27 Sarnia Arr. 0755 Dep. 0942	28 In Transit	29 CCIW Arrive 0612 hrs.	30 CCIW	31 CCIW
AUG	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW
	8 CCIW	9 Depart CCIW 1030 hrs.	10 Monitor Lake Ontario	11 Monitor Lake Ontario	12 Monitor Lake Ontario	13 Arrive CCIW 1330 hrs.	14 CCIW
	15 CCIW	16 Depart CCIW 1215 hrs.	17 Monitor Lake Erie	18 Monitor Lake Erie	19 Monitor Lake Erie	20 Monitor Lake Erie	21 Arrive Sa 1340 hrs.
	22 Sarnia	23 Depart Sarnia 1210 hrs.	24 Monitor Lake Huron	25 Monitor Lake Huron	26 Monitor Lake Huron	27 Monitor Lake Huron	28 Monit Lake Huro
	29 Monitor Lake Huron	30 Detour Passage Arr.0956 Dep.0956	31 Moorings Lake Huron	1 Moorings Lake Huron	2 Arrive Sarnia 2340 hrs.	3 Sarnia	4 Sarni
SEPT	5 Sarnia	6 Sarnia	7 Depart Sarnia 1712 hrs.	8 Limnogeology Lake Huron	9 Limnogeology Lake Huron	10 Limnogeology Lake Huron	11 Limnogeo Lake Huro
	12 Limnogeology Lake Huron	13 Limnogeology Lake Huron	14 Limnogeology Lake Huron	15 Limnogeology Lake Huron	16 Limnogeology Lake Huron	17 Arrive Sarnia 1425 hrs.	18 Sarni
	19 Sarnia	20 Depart Sarnia 1300 hrs.	21 Limnogeology Lake Huron	22 Limnogeology Lake Huron	23 Limnogeology Lake Huron	24 Arrive Sarnia 1155 hrs.	25 Sarni
	26 Sarnia	27 Sarnia	28 Depart Sarnia 0009 hrs.	29 Monitor Lake Huron	30 Monitor Lake Huron	1 Monitor Lake Huron	2 Monit Lake Huro
OCT	3 Monitor Lake Huron	4 Sault Ste. Marie Arrive 2343 hrs.	5 Sault Ste.Marie Depart 1306 hrs	6 Monitor Lake Superior	7 Monitor Lake Superior	8 Monitor Lake Superior	9 Monit Lake Supe
	10 Monitor Lake Superior	11 Moorings Lake Superior	12 Monitor Lake Superior	13 Monitor Lake Superior	14 Thunder Bay Arr.0824 Dep.1045	15 In Transit	16 In Trar
	17 In Transit	18 In Transit	19 CCIW Arrive 2143 hrs	20 CCIW	21 CCIW	22 CCIW	23 CCIW
	24 CCIW Depart 1939 hrs.	25 In Transit	26 Arrive Sarnia 1953 hrs.	27 Depart Sarnia 1223 hrs.	28 Monitor Lake Huron	29 Monitor Lake Huron	30 Monit Lake Huro
	31 Monitor Lake Huron	1 Monitor Lake Huron	2 Monitor Lake Huron	3 Monitor Lake Huron	4 Sarnia Arr. 0208 Dep. 0554	5 In Transit	6 CCIW Arrive 01
NOV	7 CCIW	8 CCIW Depart 1100 hrs.	9 Moorings & C. Chain L. Ont.	10 CCIW Arrive 1727 hrs.	11 CCIW	12 Moorings & C.C. CCIW D.1000 A.1445	13 CCIW
	14 CCIW	15 CCIW Depart 1005 hrs.	16 Monitor Lake Ontario	17 Monitor Lake Ontario	18 Monitor Lake Ontario	19 CCIW Arrive 1200 hrs	20 CCIW
	21 CCIW	22 CCIW Depart 0900 hrs.	23 Monitor Lake Erie	24 Monitor Lake Erie	25 Monitor Lake Erie	26 Monitor Lake Erie	27 Sarni Arrive 14
	28 Sarnia	29 Sarnia Depart 1232 hrs.	30 Monitor Lake Huron	1 Monitor Lake Huron	2 Monitor Lake Huron	3 Monitor Lake Huron	4 Moni Lake Huro
DEC	5 Monitor Lake Huron	6 Monitor Lake Huron	7 Sarnia Arr. 0923 Dep. 0932	8 In Transit	9 CCIW Arrive 0334 hrs.	10 CCIW	11
	12	13	14	15	16	17	18

GREAT LAKES STUDIES – 1971 – CSS LIMNOS

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	10	11	12	13	14	15	16
JAN	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31	1	2	3	4	5	6
	7	8	9	10	11	12	13
FEB	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	1	2	3	4	5	6
	7	8	9	10	11	12	13
MAR	14	15	16 Dep. CCIW 0855	17 Moorings Lake Ontario	18 Arr. CCIW 0830	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 Dep. CCIW 1130	24 Moorings Lake Ontario	25 Moorings Lake Ontario	26 Arr. CCIW 1520	27 CCIW
	28 CCIW	29 Depart CCIW 1230 hrs.	30 Moorings Lake Ontario	31 Arr. CCIW 1320	1 CCIW	2 CCIW	3 CCIW
	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
APR	11 CCIW	12 CCIW	13 Dep. CCIW 1255 Moorings	14 Arr. CCIW 2210 Lake Ontario	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 Depart CCIW 1240 hrs.	20 Pesticide Study L. Ontario	21 Pesticide Study L. Ontario	22 Arr. CCIW 1605	23 CCIW	24 CCIW
	25 CCIW	26 CCIW	27 Dep. CCIW 0905	28 Bact. & Thermal Bar Studies	29 Lake Ontario	30 Bact. & Thermal Bar Studies	1 Lake Ontario
	2 Bact. & Thermal Bar Studies	3 Lake Ontario	4 Bact. & Thermal Bar Studies	5 Lake Ontario	6 Arr. CCIW 1620	7 CCIW	8 CCIW
MAY	9 CCIW	10 Depart CCIW 1015 hrs.	11 Pesticide Study L. Erie	12 Pesticide Study L. Erie	13 Pesticide Study L. Erie	14 Pesticide Study L. Erie	15 Arr. CCIW 0820
	16 CCIW	17 Dep. CCIW 1100 Moorings	18 Arr. CCIW 1430 Lake Ontario	19 Dep. CCIW 1030 Moorings	20 Arr.P.Colborne 1950 L. Erie	21 Port Colborne	22 Port Colborne
	23 Port Colborne	24 Port Colborne	25 Port Colborne Dep. 1602 hrs.	26 Organic Part. Study L. Erie	27 Organic Part. Study L. Erie	28 Organic Part. Study L. Erie	29 Port Colborne Arrive 2037 hrs.
	30 Dep.P.Col. 1130 Arr.P.Weller 2035	31 Port Weller Dry Dock	1 Port Weller Dry Dock	2 Port Weller Dry Dock	3 Port Weller Dry Dock	4 Port Weller Dry Dock	5 Port Weller Dry Dock
	6 Port Weller Dry Dock	7 Port Weller Dry Dock	8 Port Weller Dry Dock	9 D.0805 P.Weller Arr. 1155 CCIW	10 CCIW	11 CCIW	12 CCIW
JUNE	13 CCIW	14 Dep. CCIW 0915 Pesticide Study	15 Arr. CCIW 1140 Lake Ontario	16 CCIW	17 Dep. CCIW 1235 Moorings	18 Arr. P.Colborne 1235 L. Erie	19 Port Colborne
	20 Port Colborne	21 Port Colborne Depart 1833 hrs.	22 Organic Part. Study L. Erie	23 Organic Part. Study L. Erie	24 Organic Part. Study L. Erie	25 Arr. CCIW 0555	26 CCIW
	27 CCIW	28 Dep. CCIW 1017 Moorings	29 Arr. CCIW 1930 Lake Ontario	30 Dep. CCIW 1318	1 Moorings Lake Erie	2 Bact. Survey Lake Erie	3 Port Colborne Arrive 1110 hrs.
	4 Port Colborne	5 Port Colborne	6 Port Colborne Depart 1042 hrs	7 Grid Survey & Organic Part.Study	8 Lake Erie	9 Grid Survey & Organic Part.Study	10 Lake Erie
JULY	11 Grid Survey & Org.Part. Study	12 Lake Erie	13 Grid Survey & Org.Part. Study	14 Lake Erie	15 Grid Survey & Org.Part. Study	16 Port Colborne Arrive 0705 hrs.	17 Port Colborne
	18 Port Colborne	19 Port Colborne Depart 1100 hrs.	20 Lake Erie	21 Grid Survey & Organic Part.Study	22 Lake Erie	23 Port Colborne Arrive 0215 hrs.	24 Port Colborne
	25 Port Colborne	26 Port Colborne	27 Port Colborne Depart 0810 hrs	28 Lake Erie	29 Grid Survey & Org.Part. Study	30 Lake Erie	31 Arr. CCIW 1220
	1 CCIW	2 CCIW	3 CCIW	4 Dep. CCIW 0940	5 Heat Content Survey L. Ontario	6 Arr. CCIW 1435	7 CCIW
	8 CCIW	9 Dep. CCIW 1020 Moorings	10 Arr. CCIW 1310 Lake Ontario	11 Dep. CCIW 1000	12 Heat Content Survey L. Ontario	13 Arr. CCIW 0610	14 CCIW
AUG	15 CCIW	16 Dep. CCIW 1155	17 Coastal Chain Lake Ontario	18 Coastal Chain Lake Ontario	19 Arr. CCIW 1525	20 CCIW	21 CCIW
	22 CCIW	23 Dep. CCIW 1035	24 Moorings Lake Erie	25 Moorings Lake Erie	26 Port Colborne Arrive 2125 hrs	27 Port Colborne	28 Port Colborne
	29 Port Colborne	30 Port Colborne Depart 1055 hrs.	31 Organic Part. Study L. Erie	1 Organic Part. Study L. Erie	2 Organic Part. Study L. Erie	3 Arr. CCIW 0600	4 CCIW
	5 CCIW	6 CCIW	7 Dep. CCIW 1750	8 Towed Instrument Trials,L.Ont.	9 Arr. CCIW 2400	10 CCIW	11 CCIW
SEPT	12 CCIW	13 Dep. CCIW 1145	14 Pesticide Study L. Ontario	15 Pesticide Study L. Ontario	16 Pesticide Study L. Ontario	17 Arr. CCIW 1500	18 CCIW
	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 Dep. CCIW 1115	24 Port Colborne Arrive 1515 hrs	25 Port Colborne
	26 Port Colborne	27 Port Colborne Depart 1050 hrs.	28 Lake Erie	29 Pesticide Survey&Org.Part. Study	30 Lake Erie	1 Arr. CCIW 0830	2 CCIW
	3 CCIW	4 Dep. CCIW 0901	5 Moorings &	6 Towed Instrument Lake Ontario	7 Trials	8 Arr. CCIW 2345	9 CCIW
OCT	10 CCIW	11 CCIW	12 Dep. CCIW 2130	13 Moorings Lake Erie	14 Moorings Lake Erie	15 Sarnia Arrive 2048 hrs	16 Sarnia Depart 0000 hrs.
	17 Moorings Lake Huron	18 Moorings Lake Huron	19 In Transit	20 Port Colborne Arrive 1130 hrs	21 Port Colborne	22 Port Colborne	23 Port Colborne
	24 Port Colborne	25 Port Colborne Depart 1315 hrs.	26 Organic Part. Study L. Erie	27 Organic Part. Study L. Erie	28 Sarnia Arrive 0700 hrs	29 Sarnia	30 Sarnia
	31 Sarnia	1 Sarnia Depart 1515 hrs.	2 Geological	3 Survey	4 Georgian Bay	5 & North	6 Channel
	7 Geological	8 Survey	9 Georgian Bay	10 &	11 North	12 Channel	13 Arr. CCIW 0920
NOV	14 CCIW	15 CCIW	16 Dep. CCIW 0955	17 Moorings Lake Ontario	18 Arr. CCIW 1400	19 CCIW	20 CCIW
	21 CCIW	22 Dep. CCIW 0855 Moorings	23 Arr. 2115 Port Colborne Lake Erie	24 Port Colborne	25 Port Colborne	26 Port Colborne	27 Port Colborne
	28 Port Colborne	29 Port Colborne	30 Port Colborne Depart 0950 hrs	1 Organic Part. Study L. Erie	2 Organic Part. Study L. Erie	3 Sarnia Arr.0335 Dep.1100	4 Moorings Lake Huron
DEC	5 Sarnia Arrive 1310 hrs.	6 Sarnia	7 Sarnia Depart 0810 hrs	8 In Transit	9 A.0105 CCIW D. 1250 A.1600 Moor.	10 Dep. CCIW 0843 Arr.1418 Coring	11 CCIW
	12 END	13 OF	14 FIELD	15 SEASON	16	17	18

International Field Year for the Great Lakes

By mid-December, an extensive study had been completed for IFYGL planning, and the Canadian Field Operations Plan was ready for distribution. The manual describes in detail the methods, procedures, and schedules for the bulk of field operations for IFYGL.

Miscellaneous

A Hewlitt-Packard Model 9810-A calculator was introduced on board M. V. MARTIN KARLSEN for complete and prompt calculations of chemical and biological parameters measured during monitor cruises. A plotter to be used in conjuction with this calculator will be utilized in 1972.

As a result of plans initiated by the Public Service Commission, Conestoga College, and Georgian College, students from these community colleges joined the staff on M. V. MARTIN KARLSEN during two autumn monitor cruises for a first-hand look at sampling and observational procedures.

A "Manual of Limnological Methods" (zero draf completed in February by Technical Operations sta distributed throughout CCIW.

Greatly improved ship-to-shore communications been most evident since the new equipment has installed on both D.O.T. radio stations and on vessels at CCIW.

Two new systems have been developed by Engin which have speeded up station time on monitor considerably:

- A pump water sampling system utilizing an (Electronic Bathythermograph) to obtain dept temperature in conjunction with a submersible pu now pumped directly into the laboratory area.
- Similarly, the remote-controlled E.B.T., whi operated from the laboratory, has replaced the thermograph as a depth-temperature profiler. Wi increase in depth capacity to 400 metres, E.B.T. p may now be obtained throughout the Great System by this method.

LAKES MANAGEMENT RESEARCH SECTION

The study of man's use of the water resources of the Great Lakes Basin and some of the economic ramifications of current concern with heavy metals and other environmentally hazardous substances, preoccupied the Section's staff during 1971. These projects required very close contacts with industrial and statistical specialists of other agencies and valuable information was collected.

The Section has participated in a number of joint studies with other units at the CCIW, particularly the Environmental Quality Coordination Unit, and with other agencies. Members of the staff have represented the CCIW and the Department of the Environment at a number of meetings and have participated in international programs including the negotiations with the United States on a Water Quality Agreement for the Great Lakes, the Organization for Economic Co-operation and Development, and the United Nations Conference on the Human Environment.

Great Lakes Studies

A project, undertaken jointly with the former Economic Geography Section, Resources Research Centre, successfully produced the first map entitled "Great Lakes Water Use"[1] showing some of the most significant aspects of the human use of the Great Lakes.

The map illustrates the complexity of the v management problem and its severity, particularly i Lower Lakes. On a basis of population density, it de water withdrawals, waste disposals, fish catches, ge tion of electrical energy and irrigated crop acreag number of insert maps show physical characteristic land use, both for the basin as a whole and the shor This work was extended to allow the production series of data of different social and economic indic using water related boundaries. A systematic assemb information on all water related activities in Canadian Upper Lakes basin was started during the

In co-operation with the Environmental Qu Co-ordination Unit, detailed historical and future mates of phosphorus loadings into Lake Erie were r

Economics of Environmental Quality

A number of investigations have been undertak the Section's project to evaluate the use of mat which are potentially harmful to the environment a the Canadian economy. Collection of data has

[1]Copies of the map are obtainable from the Chart Distri Office, Canada Centre for Inland Waters or Information C at a cost of $1.00.

TABLE 2. POPULATION OF GREAT LAKES BASIN, CANADA, 1971, UNITED STATES, 1970

	Basins				
	Lake Ontario	Lake Erie	Lake Huron	Lake Michigan	Lake Superior
ADA l Population 3,034	3,730,752	1,504,559	894,897	–	142,826
TED STATES l Population 95,936	2,898,485	10,111,272	1,390,880	10,566,266	429,033

e: Canada, Statistics Canada, Preliminary Bulletin, 1971 Census of Canada.
United States, Department of Commerce, Bureau of the Census, 1970, Census of Population.

npleted on mercury and selected pesticides; work is in gress on lead and cadmium and a preliminary mination has been made of a number of other stances, e.g., polychlorinated biphenyls, beryllium, nide, and arsenic.

Each of these studies presents an inventory of the rces and uses of the material and its major com- unds in Canada. The movement of the substance from point of extraction through to consumption is ced. As far as possible the quantities involved are imated and possible points of entry into the environ- nt are identified.

A pilot study is being made to apply input-output hniques to the examination of the problem of the differing environmental impact of alternative economic strategies. Tables showing direct and indirect use of a selected group of heavy metals and their compounds have been developed for Ontario as a pilot study. Empirical industry and regional studies will be developed and aspects of the transport of hazardous materials will be examined.

In co-operation with the Energy Sector, Department of Energy, Mines and Resources, a contract study was undertaken for CCIW by Montreal Engineering Co. extending the estimates of thermal inputs to Canadian inland and tidal waters outside the Great Lakes basin and examining some alternatives for reducing thermal loads on water bodies. It was estimated that thermal inputs were 2.86×10^{10} BTU/h in 1970 and will

TABLE 3. LEVEL OF AWARENESS AND EDUCATION

Detergent Phosphates and Eutrophication Survey

	Respondent's Education		
l of Awareness	Public School or Less %	Part High School %	High School Graduate or more %
naware of controversy.	49	37	19
ware but no mention f phosphates.	32	28	31
lentioned phosphates ut no explanation.	14	23	25
/ell-informed	4	11	25

204
SP = 4.25
ficant at .001 level.

TABLE 4. WATER REQUIREMENT FORECAST MATRIX

DEMAND FACTORS / WATER USE SECTOR	POPULATION	POPULATION DENSITY	AGE STRUCTURE	FAMILY SIZE	INCOME LEVEL	NATURE OF ACTIVITY	LEVEL OF PRODUCTION	SCALE OF PRODUCTION	PRODUCTION PROCESS	SYSTEM LOSS	COST OF WATER PER UNIT*	NATURE OF WATER / UNIT	ACCESSIBILITY OF SOURCE	CLIMATE	WATER QUALITY	WATER QUALITY REGULATIONS	MAGNITUDE OF SOURCE
DOMESTIC (Residential)																	
COMMERCIAL (Trade a Finance)																	
PUBLIC (Institutional)																	
MFG.																	
MINING																	
AGRICULTURE																	
ELEC. POWER GENERATION																	
NAVIGATION																	
RECREATION																	
AESTHETIC																	

*Cost is opportunity cost which in some cases may be expressed as price

rease to 76.7 X 10^{10} BTU by the year 2000 on the is of firm peak generation at a level of 80% of alled capacity for thermal power plants, and other rces of thermal inputs operating at full capacity.

While attempting to evaluate potential beneficial s of waste heat, case studies of some actual electricity eration stations suggested that joint, central electrical ver and heat energy production plants might be ful. The demand for heat energy must follow a ilar pattern to the demand for electrical energy for nomic operations.

cial and Institutional Studies

The study of housewives' knowledge of the effect of ergent containing phosphate on eutrophication and attitudes towards detergent reformulation was com- ted. Respondents were generally concerned about lution but in August, 1970, a large proportion was aware of the phosphate controversy. The socio- nomic status and the education of the housewife and husband appeared to be the most important factor ermining the level of awareness (Table 3).

During the summer of 1971 three projects were pported by the Section: a study of municipal authori- over environmental quality matters in Ontario as bodied in the Municipal Act; and two field studies nducted by McMaster University and the University of stern Ontario. The former was a comparative study of vironmental quality by-laws and municipal councillors d officials attitudes towards them in Ontario towns on ke Erie and Lake Superior. The second was a study of native shoreline problems on Lake Erie and the ent of cognizance of these problems by the municipalities.

Projects are currently being developed to investigate attitudes towards waste water recycling and to analyze the management structure on the Upper Great Lakes.

Miscellaneous

The Section continued to act as the secretariat for the advisory committees to the CCIW and to co-ordinate the seminar series. In addition, staff took part on a number of occasions in public presentations including press and broadcast interviews and speaking engage- ments.

A number of special projects were undertaken during the year. One of the more unusual was a study of the effectiveness of the CCIW Public Relations program through a telephone survey of residents of Burlington, Hamilton and surrounding district. Of those interviewed 27% had heard of the Canada Centre for Inland Waters. Only 25% of those who had heard of the CCIW were aware that it was a research institute although half knew of its connection with pollution.

Two national reports were prepared by the Section, one for the Detergent Working Group of the OECD Committee on Eutrophication and the second, on water requirements forecasting for a special United Nations Seminar to be held in 1972. Some of the economic characteristics of different water uses described in that report are shown in Table 4. The preparation of these papers was a result of participation by the staff in departmental, national and international committees and working groups.

WATER QUALITY DIVISION

The Water Chemistry Subdivision Detachment was tively engaged in the biochemical monitoring of the reat Lakes and Georgian Bay, co-ordination of analyt- al requests, and provision of analytical support to a umber of different sections, agencies and special ojects. During the year, a total of about 55,600 mples were processed and analysed for various che- ical constituents.

In June, the laboratories and personnel were tem- orarily relocated from the trailer complex to the Pilot ant building pending completion of the main labora- ry building at CCIW.

Major projects undertaken during the year were as llows:

Great Lakes Monitoring

The Unit participated fully in 17 biochemical monitor cruises of the Great Lakes and partially in one cruise of Lake Erie by the C.C.G.S. PORTE DAUPHINE. Of these, 3 each were conducted on Lake Ontario and Lake Superior, 4 on Lake Erie, and 8 on Lake Huron. Monitor stations visits amounted to about 250 and a total of approximately 5,700 water samples, collected from designated stations, were analysed aboard ship for soluble silica, ammonia, nitrite, nitrate + nitrite, ortho- phosphate, total alkalinity and about 10,000 for filtered and unfiltered total nitrogen. A total of approximately 35,500 water samples were processed aboard ship by the detachment's staff and returned to the shore laboratory for further chemical analysis. Of these, approximately

12,130 were analysed for total phosphate, 4,000 for total and inorganic carbon, 2,500 for calcium, magnesium, sodium, potassium, sulphate, chloride, lithium, strontium, about 2,400 were or would be analysed for cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, vanadium, zinc, and 595 for boron. Also, samples were analysed aboard ship for dissolved oxygen, pH, specific conductance and turbidity by the Technical Operations Section personnel with guidance and supervision from this detachment. A total of approximately 24,480 tests were performed and as in the past, instruments, reagents and other requirements for the performance of these tests were provided by WCS detachment.

Georgian Bay Project

The C.C.G.S. PORTE DAUPHINE undertook four monitor cruises of Georgian Bay on behalf of the Centre. Approximately 54 monitor stations were visited each time. Water samples were collected and analysed aboard ship for pH, specific conductance, dissolved oxygen and turbidity by personnel from the Great Lakes Institute of the University of Toronto. Operational and technical instructions, sample bottles, some reagents and necessary equipment were provided by WCS detachment. Water samples from 32 of the 54 monitor stations were treated by G.L.I. personnel and returned to our shore laboratory for chemical analysis. Approximately 475 of these samples were analysed for soluble nutrients, total and inorganic carbon, a variety of major ions and heavy metals and about 950 for total phosphate.

Bioassay Studies

Analytical support was provided to the Biological Limnology Section's (FRB Detachment) bioassay studies on Lake Huron and Lake Superior. A number of 1 to 10 m integrated water samples were analysed aboard ship for soluble nutrients and total alkalinity while others were processed and returned to shore laboratory for further analysis. Also, a number of plankton organisms, collected by the Biological Limnology Section, were analysed.

Precipitation Chemistry

Throughout the year, continuous analytical support was provided to the precipitation chemistry studies being conducted by the Chemical Limnology Section of Lakes Division. Approximately 260 precipitation samples were analysed for pH, total alkalinity, total and soluble nutrients, major ions and selected heavy metals.

Interstitial Water Samples

About 80 interstitial-water samples from lake sediments were analysed for selected major ions behalf of the Chemical Limnology Section of L Division.

Air Sudbury Project

Twelve 'air-fallout' precipitation samples colle by McMaster University in the Sudbury area in Jan were analysed for heavy metals. The extremely h work load during the year, however, necessitated discontinuation of analytical support to this project.

Round Robin Series

The Water Quality Division continued its analy quality control throughout its laboratories by mea the Round Robin Series. The Water Chemistry division's laboratory at CCIW participated and anal a series of special samples for nutrients, major ions, heavy metals during the year.

Sample Representivity

This program was initiated in mid-August Chemical Limnology Subdivision with the collabor of the Water Chemistry Subdivision and the Tech Operations Section. A series of statistical evalua were conducted during subsequent monitor curise Lakes Ontario, Erie and Huron. Quintuplicate samples were collected from specified depths at ce stations and samples were subjected to the full ran chemical analyses conducted aboard ship. These cises proved to be very useful in assessing sa representivity and the quality of chemical analysis provided for the Great Lakes Monitor Program.

NTA Monitoring Program

Some support is provided to the following progra

(i) NTA monitoring of Hamilton Harbour

(ii) Winter monitoring of NTA in western Ontario. Sample bottles, instructions, and ne equipment for sample treatment were provi the latter program. This detachment also ha acting as a liaison between CCIW and Water Division Analytical Services Section, Ottawa, samples are being analysed.

Work Introduction Program

The detachment participated in the Public Commission's Work Introduction Program and modated 4 final-year students from Mohawk Col Hamilton during a two-week period in November.

al Studies, Research and Development

uring the year, the staff conducted a number of investigatory and developmental exercises pertaining achment's laboratory work:

) The effect of freezing on samples of lake water for soluble nutrient analysis.

) Effects of filtration on results of analyses of lake water for ammonia and total nitrogen.

(iii) The effects and comparison of the use of an all-glass and all-plastic filtration equipment for sample filtration prior to soluble nutrients analysis.

(iv) Investigation and development of an automated and sensitive method for total organic carbon analysis using the Technicon Autoanalyser (a modification of Manfred Ehrhardt's method).

Marine Sciences Branch - Central Region

The Central Region is comprised of elements of the Canadian Hydrographic Service, Ship Division and an administrative support staff. The Canadian Hydrographic Service is responsible for hydrographic surveys required for the production of nautical charts and related publications; maintenance of the I.J.C. Shore Property Inventory; operation and maintenance of electronic positioning, sonar and distance measurement systems in use at CCIW, and operation of a Nautical Chart Distribution for the benefit of the general public as well as the scientific community. A Section of the Ship Division provides and operates the ships, launches, and other marine craft required in support of hydrographic surveys and scientific research programs.

CANADIAN HYDROGRAPHIC SERVICE

Arctic Program

The field unit attached to the Polar Continental Shelf Project completed the through-the-ice survey in the Beaufort Sea and carried out sounding and ground-control surveys in Nares Strait. A preliminary position was determined for Hans Island, which lies close to the tentative boundary of the territorial seas of Canada and Denmark. Plans were completed for the final determination of the island's position in 1972 by a joint Canadian-Danish expedition.

Two Central Region hydrographers took part in the Beaufort Sea Survey carried out by the survey ship PARIZEAU.

Surveys

Ontario – Ottawa River

The survey of the Pembroke to Rapides-des-Joachims reach of the Ottawa River was completed. Modern nautical charts can now be produced for the entire stretch of the river between Temiscaming and Montreal.

Georgian Bay

A survey of McGregor Bay was carried out to determine whether the route from Georgian Bay to the eastern side of Cloche Peninsula is navigable by seaway draught ships. The detailed survey established the routes to be used by seaway draught ships and Canada Cement Lafarge Limited is proceeding with the development of a new shipping terminal in McGregor Bay.

Existing charts of Georgian Bay will be updated as a result of the 1971 revisory survey.

Lake Huron

A revisory survey was carried out and existing c the eastern part of Lake Huron will be updated pri next navigation season.

Lake of the Woods

The hydrographic survey was continued in 1 completion is planned for 1972 so that modern charts will soon be available for the whole of Lak Woods.

St. Lawrence River – Kingston to Gananoque

Surveys required for the production of mode mercial and recreational nautical charts were cont the Thousand Islands area as far eastward as Ganan

St. Lawrence River – Cornwall to Montreal

Navigation ranges and other fixed aids in the s the seaway between Cornwall and Montreal we veyed.

Manitoba

A hydrographic survey of Playgreen Lake w menced and will continue until the routes fro Winnipeg to Whiskey Jack Portage and Norway H adequately charted. The survey will also provid from which the effect on navigation of the Nels Power Project, can be determined.

Quebec

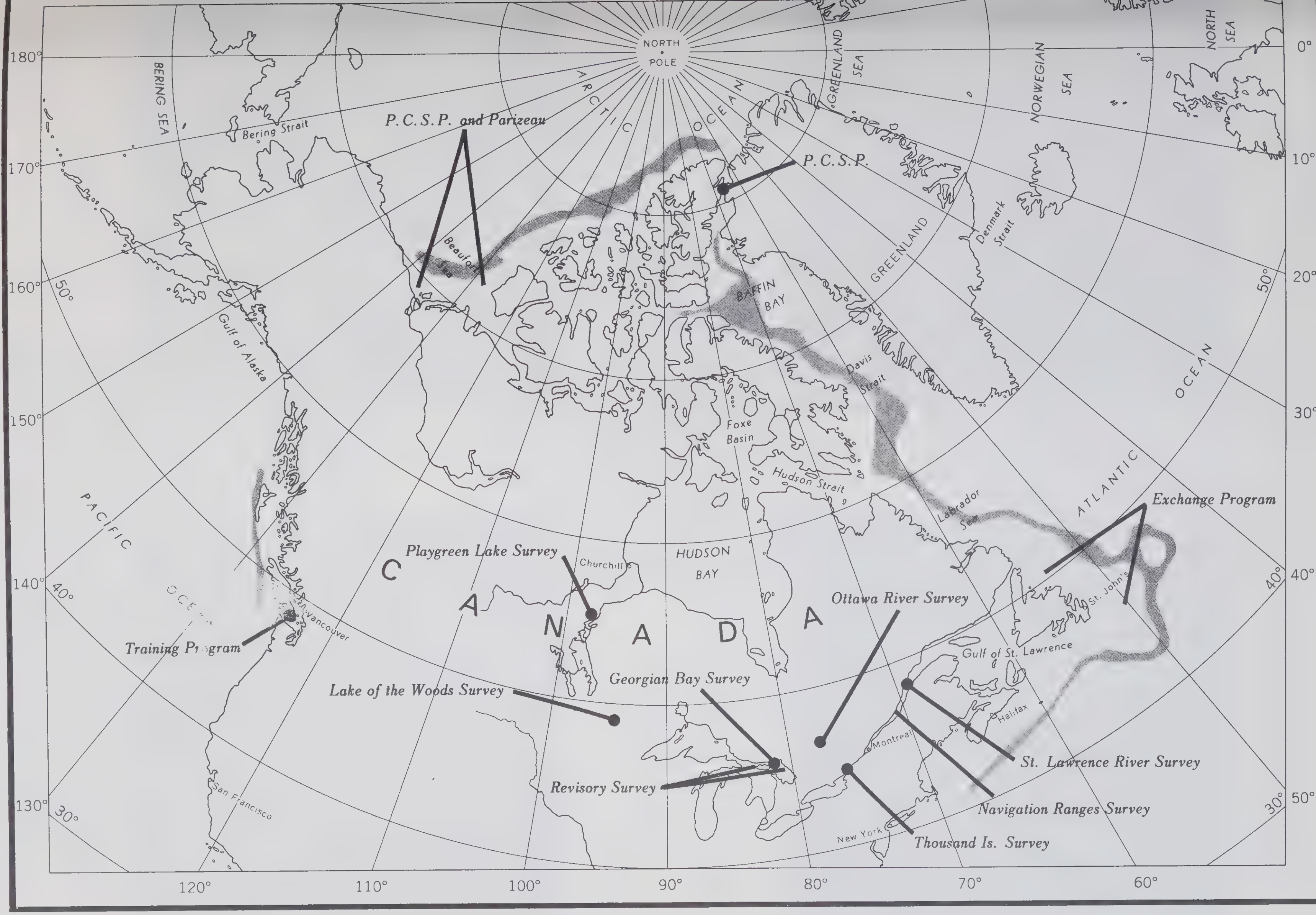
The hydrographic survey of the lower St. River upstream to Ile-aux-Coudres was continued itate production of modern nautical charts draught shipping. Large scale surveys were also ca in Quebec Harbour adjacent to new port facilities.

Limnogeology

Two field units established survey control and and maintained navigational systems in suppor limnogeology programs in Lake Ontario and Lake

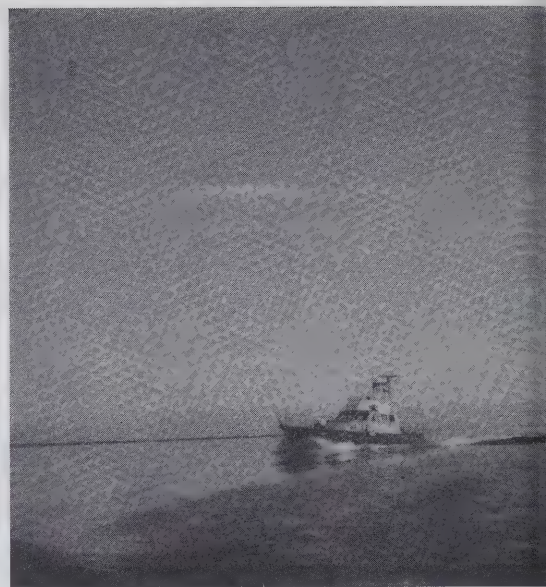
IFYGL

A contract was awarded to Computing D Canada, Ottawa for the rental and operation of Lambda Survey system to facilitate positioning and research vessels and aircraft engaged i (1972) operations on Lake Ontario.



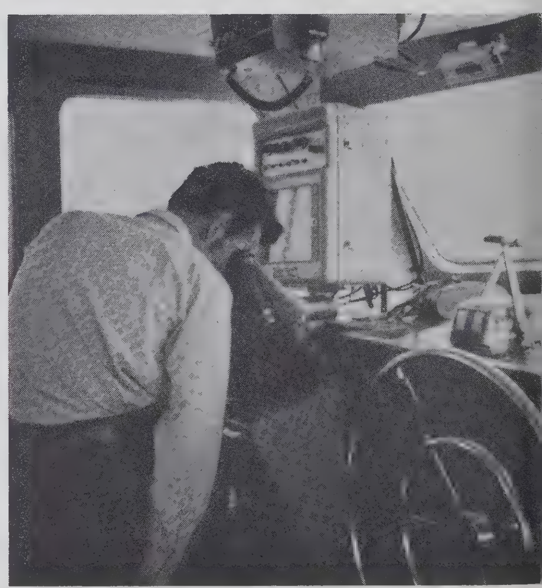
1971 SURVEYS

Revisory Survey Vessel "Vedette" at CCIW.



Revisory Survey Vessel "Vedette" at work.

Inshore work by 17-foot Boston Whaler



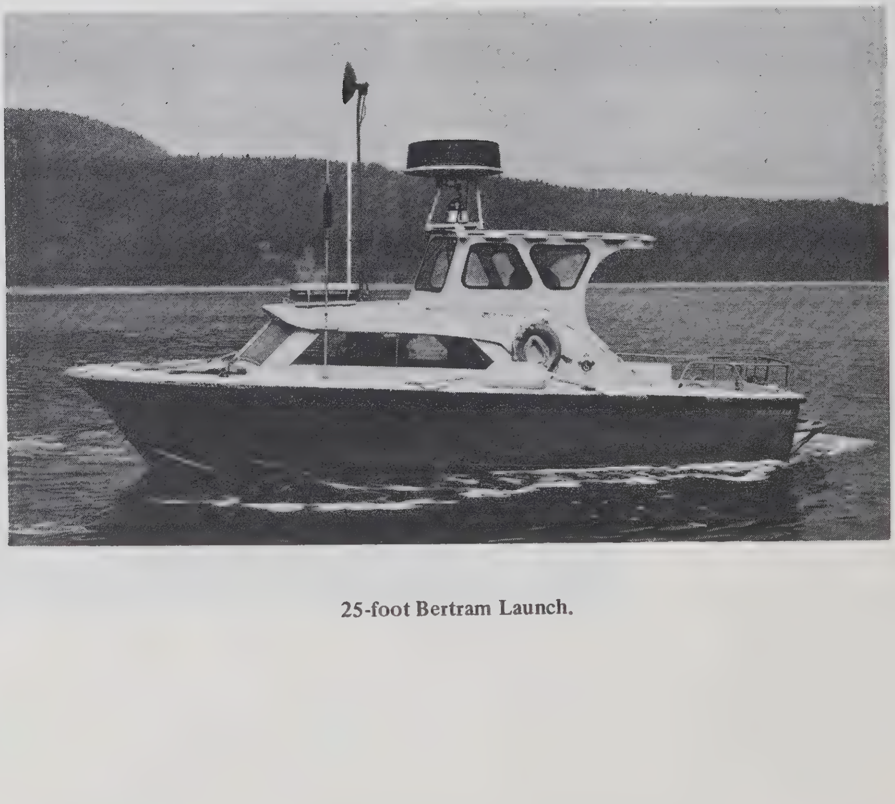
"Vedette" wheelhouse.

Ice camp 200 (1971).

Removing transducer from helicopter.

Hydrograph obtains sounding using Gifft Echo Sounder.

Interior of a 25-foot Bertram Launch.



25-foot Bertram Launch.

R.P.S. transponder installed on a 90 T.V. tower.

R.P.S. transponder installed on a light-house.

Field plotting sheet projections and Decca lattices were prepared on Central Region's Gerber–22 plotting table and supplied to Canadian Hydrographic Service headquarters where the final field sheets were compiled.

Nautical Chart Sales

A Sales outlet for nautical charts, sailing directions, and related publications of interest to commercial and recreational mariners was established at CCIW as a part of the Canadian Hydrographic Service's Marine Information Centre. Bathymetric maps of the Canadian Arctic, Lake Erie and Lake Ontario are available. The Great Lakes water use map prepared by the Economic Geography Section and the Lakes Management Research Section (CCIW) is also available through this office.

I.J.C. Shore Property Inventory

The IJC Shore Property Inventory is maintained by the Hydrographic Service and is available to the public through the Marine Information Centre, CCIW.

Tides, Currents and Water Levels

The Tides, Currents and Water Levels Section was established in July of 1971 by the appointment of a regional tidal officer. The prime responsibility of this section is to provide hydrodynamic support, specifically tidal, current, and water level, for hydrographic surveys and navigational requirements, while maintaining a strong scientific expertise. The first six months of operation consisted mainly of familiarization with the responsibilities, definition of planning guidelines, establishment of operational functions, acquisition of temporary water level gauging, review and submission of temporary gauge records, and preparation for the 1972 field season. In addition research was undertaken, in conjunction with shore property studies, into the erosive and inundative effects as well as the spatial and temporal scales, in the water level variations resulting from the storm surge on Lake Huron in August 1971.

Research and Development

The main efforts were in the areas of data processing and plotting on the Gerber 22. In the field of data processing, modifications were made to the Hypos programs so that Gerber plots could be produced on a stable base material and to ensure that the depth selection program removed redundant data. The Hypos system was again used on the Lower St. Lawrence with position data being transmitted via TWX link and sounding rolls via the mail. The quality of the processed data was vastly superior to that of past years.

A shipboard hydrographic acquisition and processing system (HAAPS) was purchased, assembled, and field t on the St. Lawrence River with very favourable results most obvious weakness of the system was the spacin soundings. However, this fault is being modified and programs being developed.

In the area of plotting on the Gerber, programs been developed to plot lattices (Mini-Fix, Decca, etc U.T.M. and polyconic projections, U.T.M. grids geographic graticules and stations, polyconic projec with stations, and Lambert conformal Projections. The Polyconic projections, Decca 6f Lattices, and U.T.M. were plotted for IFYGL program in 1972. The progra plotting U.T.M. grids was one of the most widely requ for field sheets in 1971.

A PDP-8/E was acquired and has been made availab hydrographers. All the programs were documented several new programs written for survey and positio system computations. The program library now contai Focal and 26 Fortran programs with several addit programs still in the development stage.

Further trials were conducted on the Omni-direct Scanning Sonar after modification by the manufact These trials indicated a good potential for utilizatio hydrographic and scientific surveys.

During the year, Hydrodist Digital Display Sys were designed, purchased, tested and put into operat use on hydrographic surveys. The use of these units re in a considerable increase in production operations.

Electronic Maintenance

Field support was provided for eight hydrogra survey units and four research units (IWB) as well a survey vessels LIMNOS and MARTIN KARLSEN.

The maintenance facility was improved and test pr dures developed for new equipment.

This unit is now staffed by an engineer and ten full technicians who provide the field support and perf normal maintenance routines on positioning syst distance measurement systems, sonar, radar and c munications systems valued at nearly two million dollar

SHIP SECTION

The chartered tug LAC ERIE commenced operatic February and continued up to Christmas Eve for anc very active season, principally with the Limnogeo Section.

he major vessels LIMNOS and MARTIN KARLSEN engaged in a variety of programs from March to nber, when both returned to CCIW for major refitting.

56 foot landing craft, the DUFRESNE M58, was on short term charter for the inshore sediment am. The recessed propellers permitted the craft to in much shallower water than would normally be the with a vessel this size. The 100 foot barge HANDY was also chartered briefly for use as an instrumen- platform servicing instrumented towers on the ra Bar.

he revisory survey launch VEDETTE was delivered by uilder in May and after experiencing some teething ems, worked successfully in Georgian Bay.

Launch support was extended to Playgreen Lake, Manitoba, where a new hydrographic survey was mounted and also to the Okanagan project in British Columbia. Here, a "Sea Truck", a new mini-landing craft with its own specially modified trailer was used with a good measure of success.

The marine workshops continued to provide wood and fibreglass fabrication service to various units at the Centre in addition to launch and machinery maintenance.

ADMINISTRATION

The administrative support section provided budgeting, payroll, personnel, secretarial, stores and procurement services to the region. Peak manpower was over 250 members, including seasonal ships' personnel.

Environmental Protection Service

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION DIVISION

The Technology Development and Demonstration Division, Technology and Scientific Services Branch, Water Pollution Control Directorate, Environmental Protection Service, is charged with the conception, development, and implementation of technical development programs as related to water pollution for industrial and municipal wastewaters across Canada.

The nucleus of the Division, presently consisting of 23 people, is made up of three originally separate groups: the Water Pollution Research Subdivision of the Water Quality Division with one detachment from Ottawa and another at CCIW Burlington; and the Water Pollution Research Subdivision of the Public Health Engineering Division from the Department of National Health and Welfare, Ottawa.

The Division which became operational in September is divided into four functional sections: the Process Development Section, the Laboratory Services Section, the Facilities Services Section and the Demonstration Section.

PROCESS DEVELOPMENT SECTION

The Process Development Section comprises four groups organized along process lines: (1) biological processes, (2) physical processes, (3) chemical processes, (4) soil processes.

Biological Process Group

This group is responsible for examining the biological and microbiological aspects of water pollution control systems, e.g., nitrification-denitrification, activated sludge systems, anaerobic and aerobic digestion processes, and phosphate removal processes which are biological in nature, and for toxicity and biodegradability studies.

Project priority was assigned to assess the impact of the complexing phenomenon of heavy metal–NTA–phosphate on biological waste treatment processes. Consequently, a cross-mission project between the Environmental Protection Service and the Water Management Service was initiated toward the end of the year. Bench-scale biological reactor systems were used in conjunction with controlled, metal-NTA-phosphate complex types and concentrations under controlled environmental conditions. Nutrient control by nitrification-denitrification systems are in progress; a pilot plant scale nitrogen removal syster scheduled to go on stream later in 1972.

Toxicity of ethylene glycol is studied as relate biological waste treatment systems.

Physical Process Group

The responsibilities of this group consist of pro development in the domain of physical processes suc settling, filtration, aeration, flotation, and mixing, sl dewatering and handling.

The main thrust of developmental work will be dire at the chemical sludges generated in the nutrient rem programs.

Preliminary studies were carried out at the Burlin Drury Lane Wastewater Treatment Plant on the parame affecting "luxury phosphorous uptake". In conjunc with these investigations phosphorus mass balances carried out at the plant and mathematical models obtained for the mixing in the aeration tank.

Soil Process Group

The chief area of responsibility of this group li investigating methods suitable for the disposal of efflu and chemical sludges using soil systems. Areas of con consist of characterizing the leachate from these slu and the role different soil systems play in removing va waste constituents. Close co-operation with the Departn of Agriculture on both federal and provincial levels agricultural colleges has been established.

A recent project consisted of spray irrigating a plot a waste effluent from a fish-processing plant. The obje of the program was to assess the capacity of the *in situ* system to remove carbon and nitrogen.

Chemical Process Group

This group carries out developmental work in chen processes for the removal of undesirable and potent harmful constituents from waste streams. Of immec concern and involvement is the removal of phosphate chemical processes.

As a pilot project, a number of federal facilities (DND es) are under investigation in order to determine the imum process for removal of phosphate at each ation. A highly controlled study of effects of various ergent formulations is being conducted at Canadian ned Forces Base Gloucester. Detergents with phosphate tent ranging from zero to a high concentration and A-based detergents are used by the consumer. The ponse of the consumer, and the waste treatment system assessed. The relationships between detergent formula- n and chemical phosphorus removal are also being estigated.

In addition, an experimental program for jar testing was igned in conjunction with each detergent formulation. purpose of this investigation was to assess possible rrelationships between NTA, phosphate and heavy als and the chemical removal of phosphate by using , Al^{+++} and Fe^{+++} salts. The relative contributions of each ergent formulation to wastewater and the overall ogen and phosphorus budgets of the Gloucester waste- er-treatment plant were evaluated. This study is sched- d for completion in April 1972.

The effect of NTA on the phosphate removal process is g investigated at Waterdown Ontario Sewage Treat- t Plant.

DEMONSTRATION SECTION

The Demonstration Section implements and monitors erimental investigation programs in the field.

From July to December, a study was conducted at stead Fisheries Limited, Wheatley, Ontario, in peration with McMaster University. The object of the ly was to characterize the effluent from a freshwater -processing plant and to conduct physio-and bio- tability studies. Information obtained from this gram will aid in establishing rational design parameters waste treatment systems used for freshwater fish- cessing plants. While limited biological treatability was onstrated, air-flotation as a pre-treatment process was nd to show considerable promise.

Studies continued on the development of a suitable ogical process for the treatment of mine wastewaters taining thiosalts. Engineering parameters to be used for design of full-scale mine water wastewater-treatment ems were developed. Partially, as a result of these lies, a major base metal mine in New Brunswick alled a full-scale biological system for the treatment of r mine wastewater.

To assist in finding a solution to the complex problem of the removal of toxic heavy metals from acidic mine waters, studies were conducted to determine the minimum residual metal concentrations in synthetic solutions after the addition of precipitation chemicals.

LABORATORY SERVICES SECTION

This Section is responsible for providing the analytical support required for the various projects in which the Division is engaged.

During the year the laboratory facilities were established in the pilot plant and new analytical equipment and instrumentation installed.

To meet the anticipated requirements of continuous pilot plant operation great emphasis is being placed on automated analyses.

FACILITIES SERVICES SECTION

The Facilities Services Section operates and maintains the various pollution control process units in the pilot plant and ensures that new pollution control process hardware is assembled according to designs generated by the Process Development Section.

During the year the pilot plant building was completed and one pilot unit put on stream. A pilot unit was moved with Public Health Engineering Division and was set up in the pilot plant area of the building. It was expected that the installation of the mezzanine floors would be completed by the end of December permitting an early start in 1972 on the piping, electrical and other service contracts that in part use the mezzanine structures for support.

Present projections are that the additional pilot plant facilities consisting of physical, chemical, and biological process systems will be on stream by late 1972.

CANADA-ONTARIO AGREEMENT FOR NUTRIENT CONTROL IN THE LOWER GREAT LAKES

Mr. A.R. Townshend and Dr. E.E. Shannon served as EPS representatives on the Technical Committee for the Canada-Ontario Agreement which recommended priority projects to the Board of Review for funding under the Agreement.

As a consequence the following EPS projects were funded under the Agreement:

1. NTA level and phosphorus removal relationships at the Waterdown sewage-treatment plant.
2. Use of quicklime for phosphorus removal. This is a

EPS pilot plant project at CCIW.

3. Purchase of a centrifuge to be used in full-scale sludge handling studies to be carried out at Canadian Forces Bases Camp Borden, Trenton, Petawawa, and Uplands.

MICROBIOLOGY

The Microbiology Laboratories moved from Public Health Engineering (PHE) Division offices in Kingston to new temporary quarters in the Research and Development Building, CCIW, in the spring of 1971. By the end of the fiscal year another move will have been made, this time to our new permanent quarters on the fourth floor of the Administration and Laboratory Building.

The Microbiology Section continued to broaden its horizons and initiated or supported studies in the following areas: NTA degradation; oil degradation; contract reviews; monitoring of St. Lawrence River and the upper Great Lakes; Water Pollution Control and Abatement; Indian Reserves; pulp and paper mill lagoons, Lake Ontario thermal bar; Lake Erie organic particle study; nitrogen cycle in Lake Ontario sediments; and determination of bacterial nutrients in Lake Erie sediments.

Monitoring Programs

Using a field laboratory set up in the Kingston PHE Division offices, bacteriological support was provided to three monitor cruises of the International Section of the St. Lawrence River. These studies (May, June, and September) were of approximately ten days duration. With the completion of the eight monitor cruises listed below, the planned Great Lakes off-shore monitoring program was finally completed.

Vessel	Date	Lake
Port Dauphine	April 18–April 26	Georgian Bay
Port Dauphine	Aug. 23–Aug. 31	Georgian Bay
Port Dauphine	Oct. 25–Nov. 5	Georgian Bay
M.V. Martin Karlsen	May 17–May 25	Lake Huron
M.V. Martin Karlsen	July 19–July 27	Lake Huron
M.V. Martin Karlsen	Oct. 25–Nov. 5	Lake Huron
M.V. Martin Karlsen	May 25–June 2	Lake Superior
M.V. Martin Karlsen	Oct. 5–Oct. 16	Lake Superior

In July, a staff member participated in a special Lake Erie cruise designed to monitor and trace the effects of a raw sewage spill from Cleveland, Ohio.

	River	Lakes	Total
No. of Samples	207	1521	1728
No. of Tests	1642	10643	12285

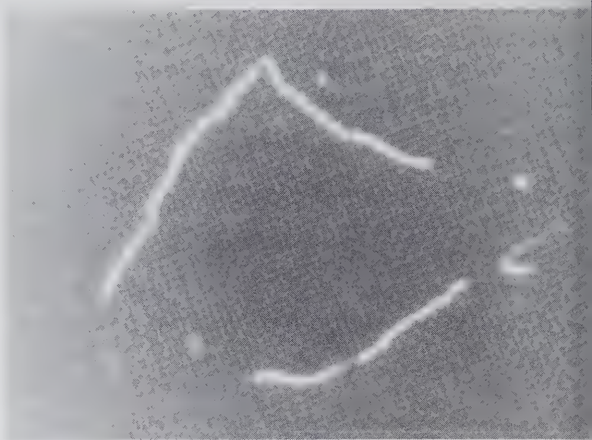


Figure 19. Recently-developed fluorescent microscopy techn combined with membrane filtration are used to est bacterial biomass in water samples.

Lake Erie Organic Particle Study

A multidisciplinary research study of Lake Er carried out jointly with the Chemical Limnology nology, and FRB Sections of ~~Rakes~~ Division. A total samples were collected and 1313 tests performed.

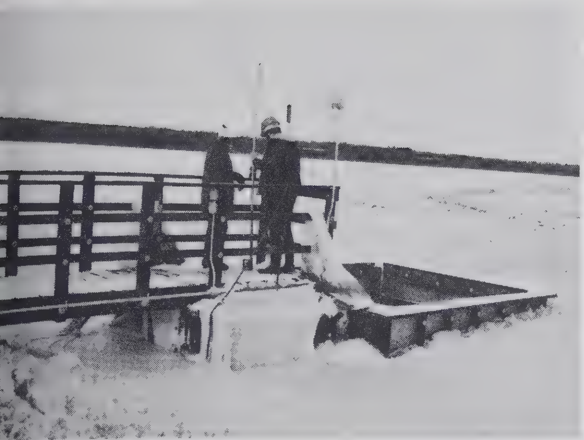
Lake Ontario Thermal Bar

Thermal bar studies – April 27 – May 6: 403 sa 1612 tests – confirmed the interpretation of data co during 1970 that the thermal bar does have a sign effect on the distribution of bacteria in areas o Ontario influenced by the bar.

Sediment Studies

Several projects were initiated and supported area. A joint project to study the nitrogen cycle i Ontario sediments was undertaken with Lakes D Support was provided to investigate seasonal and distribution of bacteria in selected Lake Ontario sed

Several studies were initiated to investigate the e organic nutrients on the distribution of hetero bacteria in Lake Erie sediments. Analytical techniqu modified and developed to determine carboh protein, and lipids in these sediments – 87 sample tests – to support this project.



e 20. Bacteriological sampling conditions at Ontario and Minnesota Pulp and paper Mill Lagoon, Fort Francis, Ontario, December 1971.

Indian Reserve Studies

Support was provided to bacteriological studies (136 samples, 581 tests) carried out by the PHE Division, Kingston, Ontario, in four Indian Reserves: Oshweikan, Dokis, Nippissing, and Oneida.

Water Pollution Control and Abatement Studies

Bacteriological support was provided to seven WPC & A studies (124 samples, 483 tests) carried out by PHE Division, Kingston at Canadian Forces Base Trenton and Warkworth Penitentiary.

Ontario and Minnesota Pulp and Paper Mill Lagoon

The Ontario and Minnesota Pulp and Paper Co. Ltd. in Fort Francis, Ontario, began using a new aerated lagoon to treat the wastes from its newly built Kraft Mill. Several

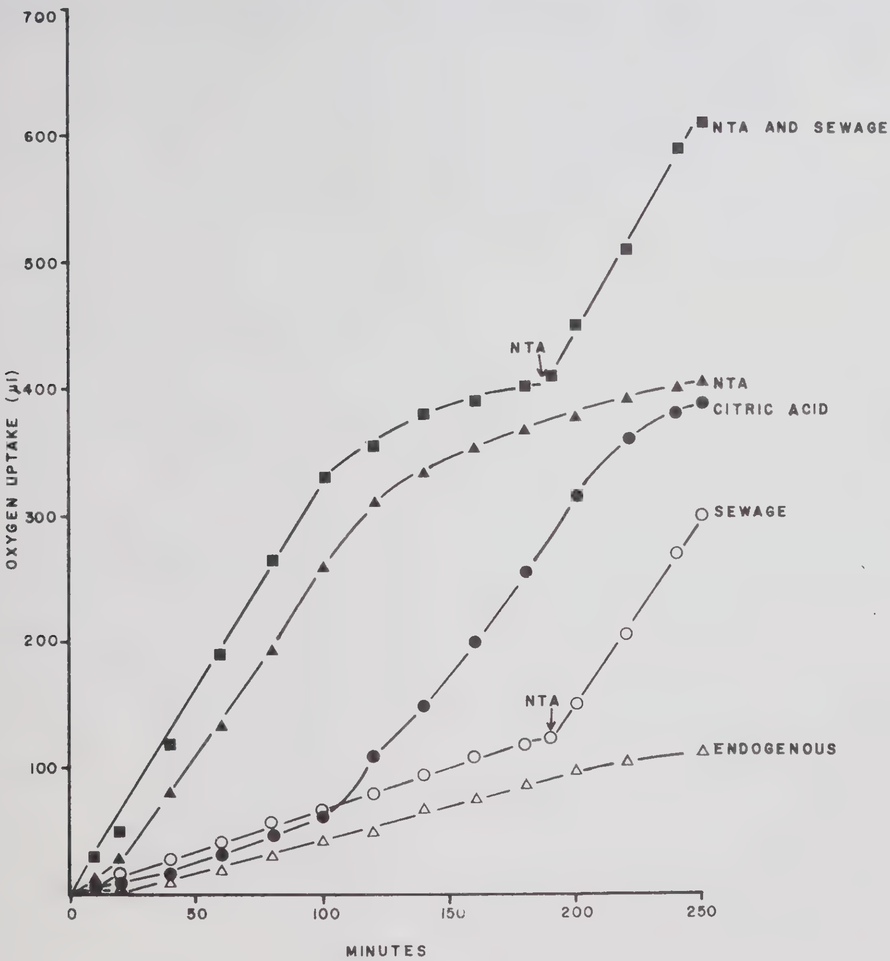


Figure 21. Rate of oxidation of nitrilotriacetic acid (NTA) (▲ – ▲), citric acid (● – ●), sewage (○ – ○) and NTA plus sewage (■ – ■) by the bacterial mutant. After 180 minutes incubation, additional NTA was added to flask containing sewage or sewage plus NTA. Note the immediate increase in oxygen consumption after the addition suggesting that NTA was being utilized by the bacterial mutant.

investigations have been planned to study the bacterial flora of this lagoon during its first few years of operation (Figure 20). The principal aim of these studies is to detect whether *Klebsiella pneumoniae* and other potential pathogens such as Salmonella are propagated in this lagoon and are discharged into the receiving stream, the Rainy River. The initial study of this project was carried out from November 24 – December 3, 1971. About 132 samples were collected and 1380 tests carried out.

Hydrocarbon Degradation Studies

Several contracts and grant applications related to bacteriological and mycological degradation of various hydrocarbons were reviewed.

Detergent Biodegradation Project

The main objective of this project is to study the factors influencing biodegradation of detergents, in which phosphate was replaced by other compounds withi sewage treatment system. Emphasis has been given t study of the mechanisms of NTA degradation; late study will be expanded to include detergents having potential substitutes for phosphates.

A bacterial mutant was isolated from sewage afte mutagenization and penicillin selection. This mutant found to readily use NTA as sole carbon, nitrogen energy source at temperatures varying from 4°C to Studies have shown that the mutated strain multiplie faster rate in sewage in the presence of NTA than i absence of NTA (figure 21).

It is hoped that this mutant can be used in se techniques to remove NTA from sewage.

After field trials, attempts will be made to ex enzyme (s) from the mutant and use the enzymes to sewage or to hydrolyse NTA in detergents.

tral Services (Provided by Inland Waters Branch)

CANADIAN CENTRE FOR INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

he Centre provided staff and facilities for the coor-ion of the Canadian scientific program for the Inter-nal Field Year for the Great Lakes (IFYGL). The am is being implemented by means of about 90 dual projects carried out in, or supported by, the ving laboratories:

AGENCY	LABORATORY LOCATIONS	
onment Canada	Atmospheric Environment Service Toronto, Ontario.	(AES)
	Atlantic Oceanographic Laboratory Dartmouth, Nova Scotia.	(AOL)
	Canada Centre for Inland Waters Burlington, Ontario.	(CCIW)
	Canadian Wildlife Service, Ottawa, Ontario.	(CWS)
	Great Lakes – St. Lawrence Study Office, Cornwall, Ontario.	(GLSL)
	Hydrologic Sciences, Ottawa, Ontario and Calgary, Alberta.	(HS)
	Marine Sciences, Ottawa and Burlington, Ontario.	(MS)
	Water Survey of Canada, Guelph, Ontario.	(WSC)
rtment of Energy, Mines Resources	Canadian Centre for Remote Sensing, Ottawa, Ontario.	(CCRS)
	Earth Physics, Ottawa, Ontario.	(EP)
	Geological Survey of Canada, Ottawa, Ontario.	(GSC)
nal Museum of Canada	Ottawa, Ontario.	(NM)
rio Water Resources Commission	Toronto, Ontario.	(OWRC)
rio Department of Lands and Forests	Picton and Wheatley, Ontario.	(ODLF)

he Universities of Toronto, Waterloo, Queen's, ster, Trent, Windsor, and Western Ontario are con-ng various projects.

uring 1971 the most significant features have been the rmation of U.S.A. participation through the National nic and Atmospheric Administration (NOAA) partly rted by ear-marked National Science Foundation) projects, and the development of the Canadian and . parts of the biological and chemistry program. The vational phase of the project was reviewed and finally run from 1 April 1972 to 31 March 1973 with a v of the program late in 1972 to consider perfor-e. Feasibility studies continued, a publications policy volved, a study of the Canadian Summarized Data File ompleted, and agreement was reached to establish a hared position fixing system. An International Work- on the Scientific Program was organized, and the ists' plans were translated into operational schedules.

bility Studies and Intercomparisons

uring the summer season, an intercomparison of g gear and techniques was conducted between the Ontario Department of Lands and Forests and the U.S. Bureau of Sport Fisheries and Wildlife. The results of the study have led to the experimental design of the Canadian-U.S.A. cooperative program of IFYGL fish studies.

From 3 September, to 14 October 1971 direct measurements were made of atmospheric boundary layer fluxes of heat, vapour, and momentum. The work was done at an over-lake site near Niagara-on-the-Lake. Scientists from the CCIW, the Atmospheric Environment Service, the Bedford Institute of Oceanography, and the National Aeronautical Establishment made simultaneous observations using several individual sets of ground level and airborne equipment. Logistic support on the lake was provided by CCIW.

From 7 September, to 8 November 1971 the newly-developed U.S.A. radio-telemetered buoy system for lake-wide atmospheric observations, lake currents, and temperatures was compared with the two Canadian tape-recording systems which make the same observations. The Canadian data return from the test site near Rochester, New York, was 95% complete and, after scrutiny and checking, was delivered to the U.S. scientists within one month of recovery. An international team is now evaluating all the observations.

On 29 May 1971 the third 60,000 ft. altitude NASA over-flight of the western Lake Ontario Basin was undertaken. The previous flights were conducted on 6 July 1970

Figure 22. A 15 by 15 km portion of Lake Ontario, photographed from 60,000 feet on 6 July 1970. The line running diagonally across the frame is the track of the CCRS CF100 aircraft working at a lower altitude. The regular wave-like features are the surface indications of internal waves probably associated with lines of surface convergence.

Figure 23. The mouth of the Niagara River and its pollution plume in Lake Ontario, photographed from 60,000 feet by NASA in a cooperative program. Clearly shown are the sail boats moored up to the line of the International Boundary from Youngstown, New York, about 2 km from the river mouth.

19 October 1970. The 10,000 sq. mile area extended from latitude 44°20′ to 42°45′N and west from 5′ to 80°20′W. All flights were timed to simulate the ng conditions planned for the U.S.A. Earth Resource nology (ERTS) satellite, which is now due for delayed hing in June 1972.A major objective of this feasibility is to fill gaps in our knowledge of the ground-water moisture component) storage term, but limnological mation for CCIW scientists was also obtained. There indications of internal waves (See figure 22), the lent characteristics of large plumes were noted (See 23), and observations were made of sediment port in coastal regions. The land basin studies were rtaken at Guelph and McMaster Universities with ort from the United States Geological Survey. At ph University a technique was developed to derive stent and representative tonal values and density ngs from the photographs. These arrangements for the sion of remotely sensed data to CCIW and other dian scientists is the culmination of plans laid in June , following discussion between CCIW, AES, OWRC, ph University and the USGS, in the framework of the national Field Year for the Great Lakes held at CCIW.

he instrumentation system for the atmospheric water et experiment was decided. Previous feasibility studies, an error analysis, showed clearly that standard wind-ng equipment was not accurate enough to observe tly the atmospheric transport of water vapour over Ontario. A suitable equipment which uses the AN-C system was available and is being procured by da and the U.S.A. to equip a total of six shoreline ns. On 30 November 1971 a special radio sounding was made during a lake-effect storm as a part of the ration for this project.

cations and Data

detailed study was made of the Canadian data, and ats for summarization (e.g., hourly value tables, etc.) drawn up to examine the size, nature and cost of a narized data file on both microfilm and magnetic tape. ould comprise hourly or daily value tables and lead s giving brief details of the instruments and methods and the nature and availability of raw data. The t will be published by the IHD Secretariat in the eedings of the IHD Workshop Seminar on Computer ng and Processing of Hydrological Data, held in Quebec City, October 1971.

A part of the groundwater studies was completed with the publication of Inland Waters Branch Technical Bulletin No. 23, (Regional Groundwater Flow between Lake Simcoe and Lake Ontario), by C.J. Haefeli of Hydrologic Sciences Div. Work on the IFYGL bibliography with abstracts and background reading list has continued; five sections have now been issued from CCIW Library.

The Second International IFYGL Workshop was held at McMaster University, Hamilton, Ontario, from 7-9 July 1971. The Proceedings of the Workshop were prepared at the Centre and distributed in September to 300 IFYGL participants.

The coordinator was appointed editor of the Canadian part of the International IFYGL Bulletin. Material of Canadian origin will be prepared in Canada and replicated and bound in the U.S.A.

The editing of IFYGL manuals has continued by the coordinator for publication by the IHD Secretariat.

Staff

For over 11 months of the year staff comprised of Mr. J. MacDowall, Canadian coordinator, IFYGL and Mrs. A. O'Hara (Secretary). In December, Mr. B. Farnworth joined as editorial assistant and Mrs. R. Veerdonk as stenographer. For a period of the year, Mr. Paulos Youakim, from CCIW Technical Operations Section, was assigned to the coordinator in order that all scientific program demands could be quickly translated into technical operations plans with regard to schedules of ship observations, track placement, and service of tower and buoys, etc. Final plans will be published in March 1972.

Remote Sensing

Mr. J. MacDowall was Vice-Chairman of the Canada Centre for Remote Sensing, Working Group on Sensors. Four meetings were held and the group assisted with the monitoring of sensor development contracts in Canadian industry and universities. The first year's work of the group was published in December 1971 as a special remote sensing supplement to the Canadian Aeronautics and Space Institute Journal edited by Mr. MacDowall.

ENGINEERING AND SCIENTIFIC SUPPORT DIVISION

he Engineering and Scientific Support Division ides the major portion of the technical and professional support required for the scientific programs at the Centre. It consists of four sections. The activities of each section

are discussed below.

ENGINEERING SYSTEMS

The Engineering Systems Section provides instrument engineering services to all divisions and agencies of CCIW and the scientists of the Association of Universities and Colleges of Canada participating in the research program of the Centre. These services include the design, development, construction, and maintenance of instrumentation systems and automatic data acquisition and processing systems. A major portion of the year's effort was directed to preparation for the forthcoming IFYGL.

Table 5 shows those projects or systems which required Engineering Systems involvement in terms of development, modification, up-grading, procurement, maintenance and related engineering participation. A description of representative engineering projects in 1971 follows.

Precipitation Sampler – Type ARC MKV–Wind Di Sensor

A system was developed to permit sampling f specific wind direction of precipitation for chemic lyses. This was achieved by designing for the sam wind direction sensor and placing it in series wi precipitation sensor. Thus, both precipitation and wind direction must be present for the lid of the sam open. Since sampling is required year-round, a h element was added to the sampler, with a then calibrated to turn on at 0±1°C, to prevent freezing moving parts. The sampler was put into use in the f September, 1971.

Sedimentation Rate Water Sampler

This apparatus (Figure 24) has been evolved to the rate of free fall of organic particles in lake water determined with minimal interference from the wind,

TABLE 5. PROJECT/SYSTEM SUMMARY CHART (1971)

System, Equipment, or Project	Quantity	Salient System Characteristics
Moored, Current-Measuring Buoy Systems	15	Each with 1 to 4 self-recording current meters. Spares extra.
Moored, Meteorological Buoy Systems (Met. Packs)	11	Each with 8-channel self-recording data-logger. 11 spares extra.
Towed, Remotely-Controlled Probe (Batfish)	2	Temperature instrumentation and hydrodynan controls.
Shipboard Pumped Water-Sampling System	2	Hose-connected systems allow on-deck water quality analysis.
Moored, Temperature-Profiling Systems (FTP)	4	18-channel automatic temperature data-acquisi system.
Tower Supported Micro-Meteorological Instrument System (with 3 major sub-systems)	1	36 data channels. Wind-profile subsystem flux subsystem, air/water turbulence subsystem.
Shipboard EBT Systems	14	EBT instrumentation incorporated in major sh launches, pumped system, batfish and spares.
Towed Thermistor Chain	1	13 channel automatic temperature-depth data acquisition system.
Shoreline Temperature	7	BT equipment – sensing, recording, and telem
Benthos Core Extruder	5	
Portable Towed T/D Systems	2	Simpler towed BT equipment.
Dye Diffusion Experiments	9	Dye release mechanisms, samplers, anchors.
Solar Radiation Integrator – Printer Units	5	Part of ship's permanent data acquisition syste Also on towers.
Sedimentation Rate Bottles	6	Free-fall, organic particles determination.
Underwater Camera System	1	Special features and triggering.
Sediment Water Interface Sampler	1	Diver operated.
Precipitation Samplers	4	Direction-Sensing Facility.
Monitor Printout Unit	10	Met. pack test set.

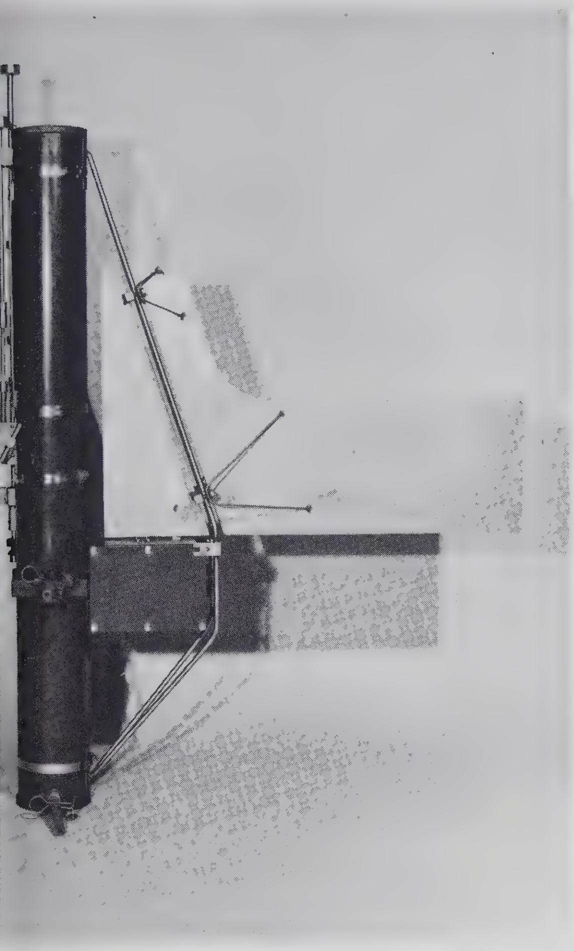


Figure 24. Sedimentation-rate water sampler.

rom the support vessel. The system consists of one or sampling bottles fastened to a wire which is kept taut e upward pull of a spar-type subsurface float. At the of the float is a battery operated timing device and at op is a release mechanism for a small surface marker The sampling bottles consist of a 1-m long P.V.C. ler, with end plugs and an actuating mechanism from dard Van Dorn bottle. At a position one-third up the ler is a shutter mechanism which, when actuated, will off the two portions of the cylinder.

he method of operation is as follows: the entire n is lowered into the water from the side of the vessel. releasing a slip line to the subsurface float, a anical messenger is released, which closes the end of the sampling bottles and starts the timer. The then moves away and after a predetermined interval, imer releases a second messenger which closes the ers of the sampling bottles and simultaneously releases surface marker buoy. The entire system is then ved and the samples of water are collected separately from the lower and upper sections of the bottles.

Sediment/Water Interface Sampler

This sampler (Figure 25) consists of a box with dimension of 18 X 18 by 12 inches, which is lowered to the bottom of the lake by cable from a vessel and is diver operated. Initially, the sampler is open at the top and bottom so that it can be set into the sediment to the desired depth. The top and bottom lids are then slid into position to seal completely the sediment and interstitial water sample with minimal disturbance. The sampler is then raised to the deck of the vessel where it is immersed in a bath of water to eliminate any gradual leakage of sample material.

Tests can be effected through the lid of the sampler to determine such parameters as sediment/oxygen demand rates of the sample, and also the chemical changes that occur as the sample goes into the anoxic state.

Ships' Pumped Water Sampling

Due to the effectiveness during the past season of the original breadboard pumping system for routine monitor sampling, a more refined, operational system has been developed. The new system is capable of pumping from depths to 100 m with a clearing time in the pipe of $1^1/_2$ minutes. Handling of the system is greatly improved by the use of integral electrical conductors molded around the outside of a flexible pipe.

Additional remote water quality sensors can be added to this system as they become developed. Other refinements consist of improved handling of the special hose reel, plus an anti-icing provision.

COMMON USER SCIENTIFIC LABORATORIES

Radiochemistry Laboratory

The laboratory became operational during 1971, with the acquisition of instrumentation for measuring disintegration rates of radionuclides and appointment of staff. Installation and testing of instrumentation occupied most of the time during the year, but a start was made on two projects which support CCIW objectives.

The first is a neutron activation analysis service, aimed initially at identifying the source of polluting oil. Samples of oil, crude and processed, from various sources are being analyzed for trace elements, by irradiating with neutrons in the McMaster University nuclear reactor, and then measuring the γ-rays emitted by the radio-isotopes produced. These γ-rays are detected with a liquid nitrogen-cooled germanium (lithium-drifted) diode, which resolves

them with respect to energy. The output pulses from the detector are sorted with a pulse-height analyzer based on a minicomputer. Analysis of a Bunker C oil sample showed lanthanum 0.17 ppm; antimony 0.86 ppm; bromine 0.60 ppm.

The second project involves determining environmental radio-activity, natural and weapons fallout, in lake sediments. A profile of individual fallout radionuclides in a core taken from a lake bottom will yield information on recent sedimentation rates. Determination of ^{90}Sr requires chemical separation of added strontium carrier from the dissolved sediment and the β-particle emission rate measured with a low background β-counter. An automatic counting system is in use, which serially measures the β-emission rate of up to 50 sources stacked in the changer and prints out the counting data on a teletypewriter. The detector is a thin-window, gas-flow proportional counter surrounded by a plastic scintillator detector as an anti-coincidence shield to cut down cosmic ray backbround. A separation scheme is being developed to separate zirconium, cesium, thorium, cerium, ruthenium, and strontium from the dissolved sediment as stable compounds for β-particle and γ-ray emission measurement.

Electron Microscope Laboratory

The laboratory, which operates a Siemen's high resolution electron microscope, has been equipped with a vacuum evaporation unit for preparing carbon films to support specimens and for shadowing the specimens with heavy metals. A darkroom for processing the exposed plates the electron microscope has also been set up.

A joint project with the Microbiology Section has started to investigate changes in structure of bacteria are able to degrade NTA when they are grown in a NTA medium. A technique for mounting cultures o bacteria and negative staining with ammonium moly has been developed which allows observation of ex structure. An ultramicrotome will be needed to cu bacteria into thin slices in order to observe their in structure.

COMPUTER AND DATA SERVICES

The Computer and Data Services Section ha responsibility for planning and implementing elect data processing systems at CCIW. The three units comprise the Section are : (1) the Computer Applica Unit, which develops and maintains computer softwar assists the staff at CCIW in preparing programs and dat the Computer Operations Unit, which schedules operates the hardware computing facilities at the C and (3) the Data Unit which processes, quality contro collates manually collected data.

The Section's hardware facilities include a I system which is used to reformat instrumentation tapes to "computer compatible" magnetic tape; the PDP-15 which is equipped with magnetic tape drives

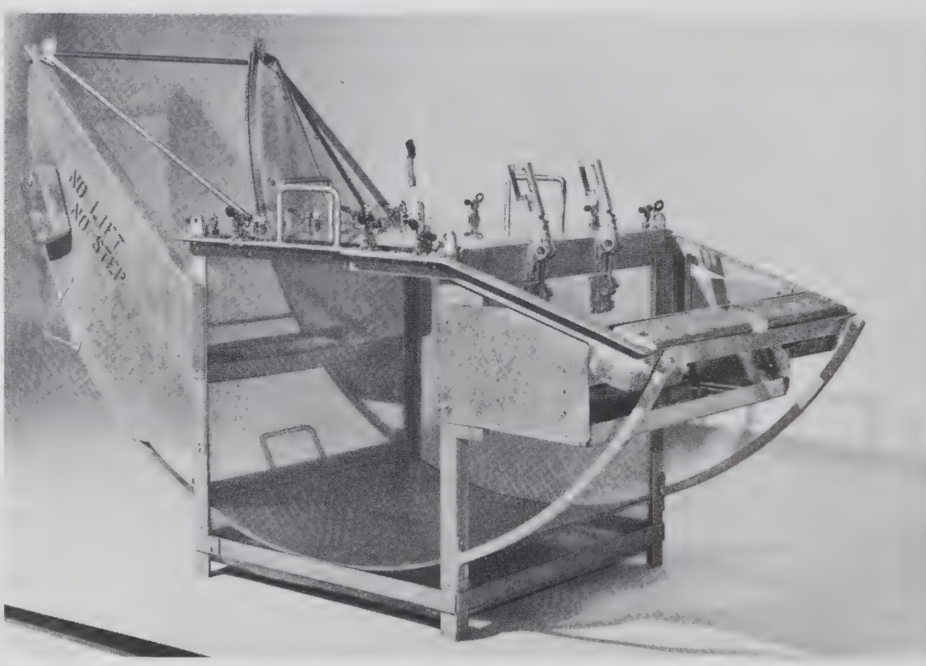


Figure 25. Sediment/water interface sampler.

rage, an interactive graphics system and a CALCOMP mp plotter and is used for special applications such as log to digital conversion, contour and three dimensional tting, data quality control and experimental program-ng languages; teletype terminal services to COMSHARE nited Sigma-7 and Multiple Access Limited CDC 3500 e available for users to interactively develop and run grams. Two larger terminals to off-site computers ried the majority of CCIW's EDP load; one terminal was nected to a Control Data 6400 at McMaster University, other terminal was connected to a Control Data 6600 at ltiple Access Limited in Don Mills, Ontario. Approx-tely sixteen thousand jobs were processed during 1971. increase CCIW's in-house computing capability, an erim computing system was installed in January 1972 il DEM&R's surplus Control Data 3100 arrives. The allation of the CD 3100 occasioned the move from the lers, home of the Section for the last four years, into the rters in the main laboratory building.

The Computer Applications Unit's detailed responsi-ties are (1) to provide consultative services to users; (2) provide reference facilities to users; (3) to write software request for scientists; (4) to anticipate, and plan future tware needs; and (5) to develop software used in e-scale data base management.

During the year, a cumulative total of 49 requests for gramming services were received, and acted upon. Of number, 19 were "ongoing projects" of more than two nths duration, and the rest were shorter requests. The uests ranged all the way from a short program to carry chemical computations, to a whole software system igned to handle shipboard data.

Data handling procedures, and software systems were eloped for shipboard (monitor) data, filed under the AR (Storage and Retrieval) system, and time-series data, d under the TSAR (Time Series Storage and Retrieval) tem. Also, systems analysis for the shipboard data flow carried out to speed up data handling procedures for nitor data, as well as preliminary studies for a system to dle biological data, and the initial planning for handling a from the IFYGL. Program documentation was carried in all cases for reference by external users, and a gram library was started for the scientific staff. A series packages for scientific analysis of data was started, which udes time-series analysis as well as statistical packages. This will be continued into 1972.

Of the 77 surveys carried out on the Great Lakes, or as part of the Okanagan Project, forty were monitor type surveys requiring processing through to the preliminary report stage, with the data eventually to be stored on magnetic tape or discs. The supplementary data such as, solar radiation, meteorological observations, mooring positions, etc. were indexed and filed; bathythermograph data were summarized and forwarded to CODC for further processing onto aperture cards. Past data of 1967 to 1970 was run through the STAR data editing and quality control program prior to being stored on tape. Listings of 1969 data, along with track charts, survey methods and references, are in the process of being printed for distribution.

As part of our data quality control program, a performance review of all reversing thermometers and bathythermograph instruments used in the field was carried out, with recommendations for recalibration of instruments being forwarded to the Operations Section.

LIBRARY AND REFERENCE SERVICES

The Library collection includes: 7,300 books, current subscriptions to 850 journals and related abstracting services, and 216 series of annual reports, data reports, etc.

Requests for 1,740 Inter-library loans were handled by Library staff and 340 items were loaned from CCIW collection to other libraries.

Collected Reprints, volume 3 (1970) was produced for distribution to institutions which exchange publications with CCIW. A quarterly bibliography of staff publications and presentations, a list of serial holdings, and monthly acquisition lists were compiled.

A computer-produced Key-Word-in-Context index to CCIW report holdings is nearing completion. It will contain in one alphabetical order subject key-words and names of authors.

Developments in information retrieval were watched during the year. One new interest profile was submitted to the National Science Library's GEOREF current-awareness service. Three demand searches on material of environmental concern were submitted to computer services.

Environmental Quality Coordination Unit

The Environmental Quality Co-ordination Unit (EQCU) co-ordinates the results of research from two or more components of CCIW with research results produced by groups elsewhere in a form designed to assist in the establishment of policies and action programs of the Department of the Environment and other Water Management agencies in Canada. EQCU assists in the dissemination of research results to water management agencies in Canada in a form which may be readily converted to action programs and public policies by these agencies. In addition, EQCU co-ordinates the contributions of CCIW to the Canada – U.S.A. Contingency Plan for Oil and Toxic Material Spills on the Great Lakes; research results and technical input to national contingency plans for freshwater regions; contributions of CCIW to Canada – U.S.A. pollution control negotiations concerning the Great Lakes, and to the International Joint Commission studies, surveillance, and control programs. Supervision is provided by EQCU for CCIW research contracts of a multi-disciplinary nature.

The Unit has continued its active role on contingency plans for combatting oil and other toxic material spills, both in the Great Lakes region and internationally. The Unit participated in the drafting of the Joint U.S.A. – Canadian plan for the Great Lakes, provided liaison with the Ontario Contingency Plan Co-ordinating Committee, provided the Chairman for the Technical Working Group for the Federal Contingency Plan and the Chairman for the CCIW Task Force on Spills of Oil and Other Toxic Material, and represented CCIW as a member of the local Hamilton Harbour Spill Control Group. During the year the joint U.S.A. – Canadian plan became operational, a Field Manual was produced by the Technical Working Group, and in support of CCIW's role in the Great Lakes Contingency Plan, considerable efforts were made to organize and co-ordinate the response of Canadian agencies in the region to possible spills. In late August the Joint U.S.A. – Canadian and Federal Contingency Plan was activated as a result of the collision and grounding of the vessel TRANS-MICHIGAN in the St. Clair River. EQCU provided support to the Director, CCIW, the Regional Coordinator, in the immediate clean-up activities and provided advice on the subsequent measures necessary to clean the ship and allow it to proceed to dry dock. In September EQCU co-ordinated and organized a debriefing session of personnel from the U.S.A. and Canadian agencies involved in the operation.

The problems of nutrient control, and particularly substitution for phosphates in laundry detergents continued to be an active topic. EQCU continued to co-ordi output of government research scientists and indus representatives. Arrangements were made for a fur multi-national meeting on NTA research during Octo Since NTA was by then being used in modest quantitie Canada, a monitoring program for NTA in the environm was initiated to permit prediction of possible environme concentrations if more wide-spread use is permitted. monitor program included a number of elements samples being collected from both coasts, the Great L region, liaison with an on-going monitoring program at Freshwater Institute in Winnipeg, initiation of a grou water sampling program, and incorporation of informa from the on-going Procter and Gamble monitoring progr NTA usage data was obtained from the Soap & Deter Association. In addition, EQCU is responsible for liaison a contract with the Ontario Research Foundation cerning evaluation of the washing effectiveness of var detergent formulations with phosphates, NTA, and citra at several water hardnesses. Overall co-ordination has b provided to the Departmental NTA program. This invo the monitor program, assessment of the potential prob of mixed NTA/phosphate complexes interfering with p phorus removal at sewage treatment plants, and studie the bacteriological degradation of NTA under var conditions. A policy paper based on the results of t programs is to be prepared early in 1972 and co-ordin with studies on health aspects underway in the Departm of National Health and Welfare.

EQCU participated in the preparation of a paper historical oxygen depletion rates in Lake Erie which presented at the 14th Great Lakes Conference. As a fol up to this paper, and a follow up to Project Hypolimn an intensive study of the hypolimnion of the central b of Lake Erie, EQCU co-ordinated the development paper to assess the phosphorus loading to Lake Erie w might just prevent the bottom waters of the central b from becoming anoxic. In conjuction with the L Management Research Unit a paper which compared historical oxygen depletion rate with the historical p phorus loading to the lakes was developed. This mat was subsequently expanded as a report to the Internati Joint Commission Lower Lakes Boards. An additi expansion was made to attempt to predict the impac the oxygen conditions in the hypolimnion in Lake Eri proposed reductions of phosphorus loading to Lake Erie the period 1970-75. A draft paper was produced presented to the Boards. Subsequently an abstract of material was used for developing a phosphorus reduc program in the context of the Canada – U.S. negotiat

an Agreement on Water Quality Control in the Great es.

EQCU participated extensively in the drafting of the osed Canada – U.S.A. Agreement on Water Quality in Great Lakes, both in support of the Canadian nego- ig team and in the preparation of a number of draft exes to the Agreement.

EQCU continued to co-ordinate the pesticide surveys in the Lower Lakes during the year and two cruises on each of Lakes Erie and Ontario were completed. In addition to measurements of the organochlorine-insecticide residues, measurements were made of PCB's .

EQCU continued to represent CCIW on a number of Interdepartmental Committees, carried out a number of international functions pertinent to the work at CCIW, and assisted and co-ordinated the preparation of background material for meetings of the IJC Advisory Boards as well as the preparation of the Reports of the Board to the IJC.

uilding Program

The construction of permanent quarters has proceeded chedule throughout 1971 and the project continues to within the budgetary limits established in 1967. The r Quality Pilot Plant was completed in May 1971, and onnel moved into the building on June 3. The ratory and Administration Building neared completion plans have been made to move into the first and second s during January 1972. These floors contain the nistration offices, the computer and data areas, the cafeteria, drafting, library, and auditorium. The laboratory floors of the building are still on contract schedule and are expected to be occupied in March 1972. Work commenced on the Hydraulics Laboratory in June 1971 and its completion is presently scheduled for June 1972. This is the last phase in building construction. Other work continuing into 1972 includes outside signage, landscaping, interior graphics, and fine arts.

Public Relations & Information Services

Management initiatives and future research depend on the understanding and active support of the general public.

Of the 78 public speaking engagements in 1971, a series of four invitations from the Erie Region Economic Council to address mayors, reeves and councillors of various cities in south-western Ontario, and an invitation from the University of Windsor's Pollution Probe were of special interest. Through the year, the demand for public speakers exceeded the resources of the Unit. Subsequently, a Speakers' Bureau Service was inaugurated and some twenty members of Centre's staff volunteered for the first roster, so th better response could be effected.

In all, the Public Relations Unit handled 33 sepa visits by various groups of people. To meet the demand tours of the Centre, plans were being made to set up a Tours Service which could be facilitated through auditorium and pedestrian mall in the Centre's perma quarters.

Staff members of the Centre are the guests of CFPL-TV's Dick Berryman on "At Random"–a popular television programme in Lo Ontario and the surrounding region. Under discussion is the Centre's Water Quality Pilot Plant, and the publication of the Lake Manage Research Section's map of Great Lakes water use patterns.

Left to right are: Miss Margaret Sinclair, Lakes Management Research Section; the show's host, Dick Berryman: A. R. Kirby, Relations Unit; A. R. Townshend, Environmental Protection Service.

A new publication, in folder form, entitled "Water and An Investment Report", addresses itself to the tax-ng public. The folder explains the Centre's purpose, k and achievements and points out the vital role of the ic in ensuring full dividends from their investment. The er incorporates a tear-off coupon which invites the er to seek further information on water management in ada, the Centre itself, other services of the Public tions Unit and of Environment Canada as a whole. As a ribution to the Centre's effort to distribute the new ication, the Windsor Utilities Commission undertook to 60,000 copies to residents of the area.

Print and broadcast media continued to show keen est in and active support of, the Centre. In addition to stories, feature stories on the Centre and its work published by Canadian Press, the Toronto Globe and Mail, the Hamilton Spectator, Dofasco Illustrated News, Country Guide Magazine and Ontario Hydro News, and in the United-States, the Buffalo Courier-Express. Researchers and management personnel were featured guests on radio and television programmes in both regional and national broadcasts. The British Broadcasting Corporation sent the producer and crew of BBC-2's "Horizon" series to interview the Director and senior researchers on work in the Great Lakes. Many interviews were arranged for London, Hamilton and Toronto television stations, and cable as well as educational television stations also broadcast programmes on the work of the CCIW.

The Ontario Science Centre cooperated in setting aside, space, manpower and other facilities to help tell the Centre's story to its more than 500,000 annual visitors through a new exhibit entitled "Spaceship Earth".

CCIW Staff List

CCIW

Director, CCIW – J.P. Bruce

Secretary – Mrs. L. Ward-Whate

Executive Assistant to Director – T.S. Hillis

Building Services Superintendent – D.F. Stewart

Support Staff, CCIW – D. Haswell, C.F. Hicks, A.W. Mayes, D. Niles, J. Slaz, Mrs. E. Rae, Mrs. B.D. Titley

Personnel Administration, CCIW – Miss R. Kelly, W.B. Christopher, Mrs. M. Duggan, Mrs. C. Shepherd, Miss M.R.J. Warren

HYDRAULICS UNIT (INLAND WATERS BRANCH)

Head – Dr. T.M. Dick

Secretary – Mrs. L. Kay

C.K. Jonys, Dr. L. Lau, J. Marsalek

LAKES DIVISION (INLAND WATERS BRANCH)

Chief – Dr. R.A. Vollenweider

Secretary – Mrs. S.M. Horne

BIOLOGICAL LIMNOLOGY (FISHERIES RESEARCH BOARD)

Head – Dr. A. Nauwerck

Secretary – Mrs. D. Moore

Dr. W. Glooschenko – pigments, toxic substances

Dr. N. Watson – bottom fauna, zooplankton

Dr. M. Munawar – phytoplankton

Dr. P. Stadelmann (Post Doctoral Fellow) – primary production limiting factors

G. Carpenter – zooplankton culturing, biomass

J. Moore – primary production, bioassays

J. Leslie – particle counting

H. Shrivastava – bottom fauna

L. Mansey – bottom fauna; nekton

H.F. Nicholson – chlorophyll, Great Lakes bibliography

R.H. Collins – field work, pigments

CHEMICAL LIMNOLOGY

Head – Dr. Mary E. Thompson – specific ion electrodes temperature aqueous geochemistry

Secretary – Mrs. Rosemary E. Morrison

Dr. N.M. Burns – nutrient cycles, especially particle settling in

Dr. Y.K. Chau – trace elements and natural complexation in

*Dr. A. Lerman – geochemistry of brines; radioisotopes in sediments

Dr. R.F. Platford – physical chemistry of aqueous solutions

Dr. W.M.J. Strachan – organic chemistry applied to lakes

Dr. R.R. Weiler – carbon cycles in lakes ; sediment geochemist

Post Doctoral Fellows

**Dr. C.W. Childs – physical chemistry of aqueous solutions

Dr. J.O. Nriagu – sulfur cycle, authigenic minerals in lakes

Dr. V. Cheam – complexation reactions of humic compounds

Chemists

M.E. Fox – soluble organic compounds in large lakes

H. Saitoh – trace elements and complexation reactions in lake

K. Lum-Shue-Chan – trace elements and complexation reacti lakes

C.H. Chan – chemistry in the lakes

M.T. Shiomi – atmospheric precipitation chemistry; nutrient in large lakes

Technical Staff

R.D. Coker, K.W. Kuntz

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*A. Lerman terminated his employment here at CCIW, Oct His forwarding address is: Dept. of Geological Sciences, western University, Evanston, Illinois, 60201.

**C.W. Childs concluded his fellowship and left for New Z June 21, 1971. His address there is: Soil Bureau, D.S.I.R., Bag, Lower Hutt, New Zealand.

OGEOLOGY

– Dr. P.G. Sly – distribution and variance of lake bottom diments

ecretary – Miss. J. Brouwers

.W. Anderson – palynology of recent sediments (Post Doctoral ellow) (GSC)

.L.W. Kemp – distribution and diagensis of organic compounds in recent sediments

.F.M. Lewis (GSC) – post-glacial uplift and stratigraphic orrelation of recent sediments

.A. Rukavina – interpretation of sediment distributions in the earshore zone

.E. St. John – trace element geochemistry

.L. Thomas – distribution, occurrence and authogenesis of inerals, major elements and heavy metals in recent sediments

.D.H. Williams – sediment/water interface exchange, with articular emphasis on the phosphate and iron cycles

Coakley – distribution, occurrence and relation to erosion, ansportation and deposition of active sediments

. Gray – diagenesis of recent organic compounds

Henry – geophysical characteristics of unconsolidated sediments

arwick (educational leave) – palaeoecological interpretation of ironomid faunas

HNICAL OPERATIONS

– H.B. Macdonald

ecretary – Miss R. Gruhl

Cooper – Senior Operations Officer; special assignments

Roe – Senior Diving Officer

Hanington – C.S.S. Limnos, Operations Officer

Brooks – M.V. Martin Karlsen, Operations Officer

Williams – A/Standards and Development Officer; Okanagan asin Study

Youakim – special projects

Benner – shore party

Carew – M.V. Martin Karlsen

Cho – M.V. Martin Karlsen and shore party

Clemmens – M.V. Martin Karlsen

F.J. de Vree – seconded to Marine Sciences Branch

F.H. Don – C.S.S. Limnos and M.V. Martin Karlsen

J.M. Gervais – seconded from Marine Sciences Branch

H. Greencorn – rigger

P.M. Healey – M.V. Martin Karlsen and C.S.S. Limnos

R.D. Hore – M.V. Marin Karlsen and C.S.S. Limnos

G.J. Koteles – M.V. Martin Karlsen

J. Lomas – Foreman-Rigger

M.R. Mawhinney – Okanagan Basin Study

B.H. Moore – C.S.S. Limnos

G.M. Perigo – rigger

J. Ross – M.V. Martin Karlsen

S.B. Smith – M.V. Martin Karlsen

W.B. Taylor – electronics technician

M.R. Thompson – M.V. Martin Karlsen and C.S.S. Limnos

S.P. Withers – C.S.S. Limnos

Technical Staff

W. Booth, Mrs. J. Coons, G. Duncan (A/Chief Technician), Mrs. L. Hoffman, Mrs. N. Harper, J. Horsman, G. LaHaie, Mrs. T. Mayer, T. Morton, Mrs. A. Mudrochova, R. Sandilands, D. St. Jacques

PHYSICAL LIMNOLOGY

Head – Dr. R.K. Lane

Secretary – Mrs. C. McMunn

Dr. E.B. Bennett – circulation, descriptive limnology

Dr. J.O. Blanton – thermal structure, demonstration basin studies

F.M. Boyce – internal waves, heat content

Dr. M.A. Donelan – air-lake interaction

F.C. Elder – air-lake interaction, descriptive limnology

P.F. Hamblin (educational leave)– circulation, seiches

B.C. Kenney – small lakes studies, circulation

H.W. MacPhail – electronics, satellite data retransmission

Dr. C.R. Murthy – diffusion, circulation

Dr. E. Nagy – oil/water studies

D.G. Robertson – descriptive limnology

Dr. T.J. Simons – hydrodynamics, modelling

Dr. K.P.B. Thomson – remote sensing

Support Staff

D. Beesley, J. Bond, R. Chapil, F. Chiocchio, H. Dobson, S. Fauman, R. Gottinger, P. Greenway, J. Hart, D. Jordon, W. McColl, K. Miners, J. Mollison, W. Moody, H. Ng, H. Nicholson

CANADIAN CENTRE FOR INTERNATIONAL FIELD YEAR FOR GREAT LAKES (IFYGL)

Canadian Co-ordinator – J. MacDowall

Secretary – Mrs. A. O'Hara

Administration Section

Head – J. Aris

Support Staff – D.G. Jefferson, Miss. I. O'Connor

LAKES MANAGEMENT RESEARCH SECTION (Inland Waters Branch)

Head – Dr. T.R. Lee – water use, economic growth and environmental policy

Secretary – Mrs. R. Riggs

G. Bangay – water use and environmental quality in the Great Lakes Basin

R. Shimizu – institutional studies

Miss M. Sinclair – perception and attitude studies

J.N. Thomson (educational leave) – economics of environmental quality

WATER QUALITY DIVISION – ANALYTICAL LABORATORIES (Inland Waters Branch)

Head – F.J. Philbert

Scientific and Technical Support: H. Alkema, K.D. Austen, W.D. Blythe, O. El Kei (educational leave), Y.M. Sheikh, G.Y. Stoddart, Miss C. Furlong

MARINE SCIENCES BRANCH – CENTRAL REGION

A/Chief, Central Region and Regional Hydrographer – T.D.W. McCulloch

Secretary – Miss L. Ram

CANADIAN HYDROGRAPHIC SERVICE

Assistant Regional Hydrographer – H.R. Blandford

Secretary – Mrs. E.M. Gervais

Hydrographers-in-Charge – Field Surveys

R.D. Courtnage	Thousand Island
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Staff Participation in Committees and Associations

Advisory Board to State University of New York's Sea Grant Programs (Lake Ontario) – J.P. Bruce

Advisory Committee on Air and Water Resources Technology, Conestoga College – Dr. R.K. Lane

American Water Resources Association, Board of Directors – J.P. Bruce

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Canada Spectroscopy Society, 4th International Symposium on Atomic Spectroscopy, June 1973, Toronto

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Canada-U.S. Agreement for Great Lakes Pollution Control

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ntracts 1971

ıdy of thermal inputs to Canadian waters. (Montreal ering Co. Ltd. – $42,000).

velopment of analytical techniques and methodology analyses of sediments and water from Lake Ontario. of Calgary, Exobiology Research Group – $15,000).

nduct a study to examine the nearshore thermal and t regimes in Lake Ontario in the vicinity of Oshawa bourg. (Univ. of Waterloo – $42,000).

aluation of water quality data result from projects the Okanagan Lakes Study. (Dr. A. Lerman, on, Ill – $4,600).

amination of fundamental physical processes in lakes pment of numerical models of lake dynamics. ado State Univ. – $4,500).

ecial investigation, modification and study of record- ater current meters. (Canadian General Electric Co. $15,300).

sistance in the development of computational ms for determining epilimnion and hypolimnion es of various lakes in Canada. (Dr. A. Gilbert –

eoretical study of diffusion of a line source of its located in the hypolimnion. (Dr. T.E. Unney, of Waterloo – $2,700).

alysis of 250 sediment samples for differential results cury. (Barringer Research – $17,270).

velopment of instrumentation for the measurement e temperature structures from moving vessels and ed buoys. (J. & P. Assoc. – $5,000).

derwater photography, sampling and topographical ations. (Underwater Survey Unit, Burlington, Ont. –

$8,250).

To provide continuous research on a project involving the geological studies of the nearshore zone of Lake Superior from Nipigon Bay to Marathon. (Lakehead Univ. – $13,500).

Repair, maintenance and servicing of Plessey and Geodyne water current meters and Hymet recorders. (Canadian General Electric Co. Ltd. – $41,450).

Study of methods for summarizing, compiling, storing and distribution of data to be obtained during the International Field Year for the Great Lakes in 1972. (McMaster Univ. – $7,890).

The following contracts from headquarters funds were monitored by CCIW staff.

Cannery waste treatment by soil biofiltration. (Canadian Canners Ltd.)

Use of plastic-media filter for wastewater treatment. (Univ. of Waterloo).

Partial nutrient removal system at Penetanguishene sewage treatment plant. (Univ. of Toronto).

Study on the efficacy of non-phosphate based detergents. (Ontario Research Foundation).

Design of hydraulic research equipment. (R.J. Kennedy).

Study on dredging of contaminated sediments (H.G. Acres Ltd.).

Evaluate the use of polyurethane as a filter medium for separating petroleum products and water, and to produce criteria for the design of full-scale filter plants. (Canadian Plant and Process Engineering Ltd.).

Environment Canada
Environnement Canada

CANADA CENTRE FOR INLAND WATERS

1972

CANADA CENTRE FOR INLAND WATERS – 1972

The Canada Centre for Inland Waters, a water research and management centre unique in North America, is situated on a land fill site beside the Burlington Ship Canal. Shown in this aerial photograph is the Centre's seven-storey Main Administration and Laboratory Building, behind the Research and Development Building, the Wastewater Technology Centre and the newly completed Hydraulics laboratory. Behind the buildings are some of the trailers that originally housed the Centre's staff.

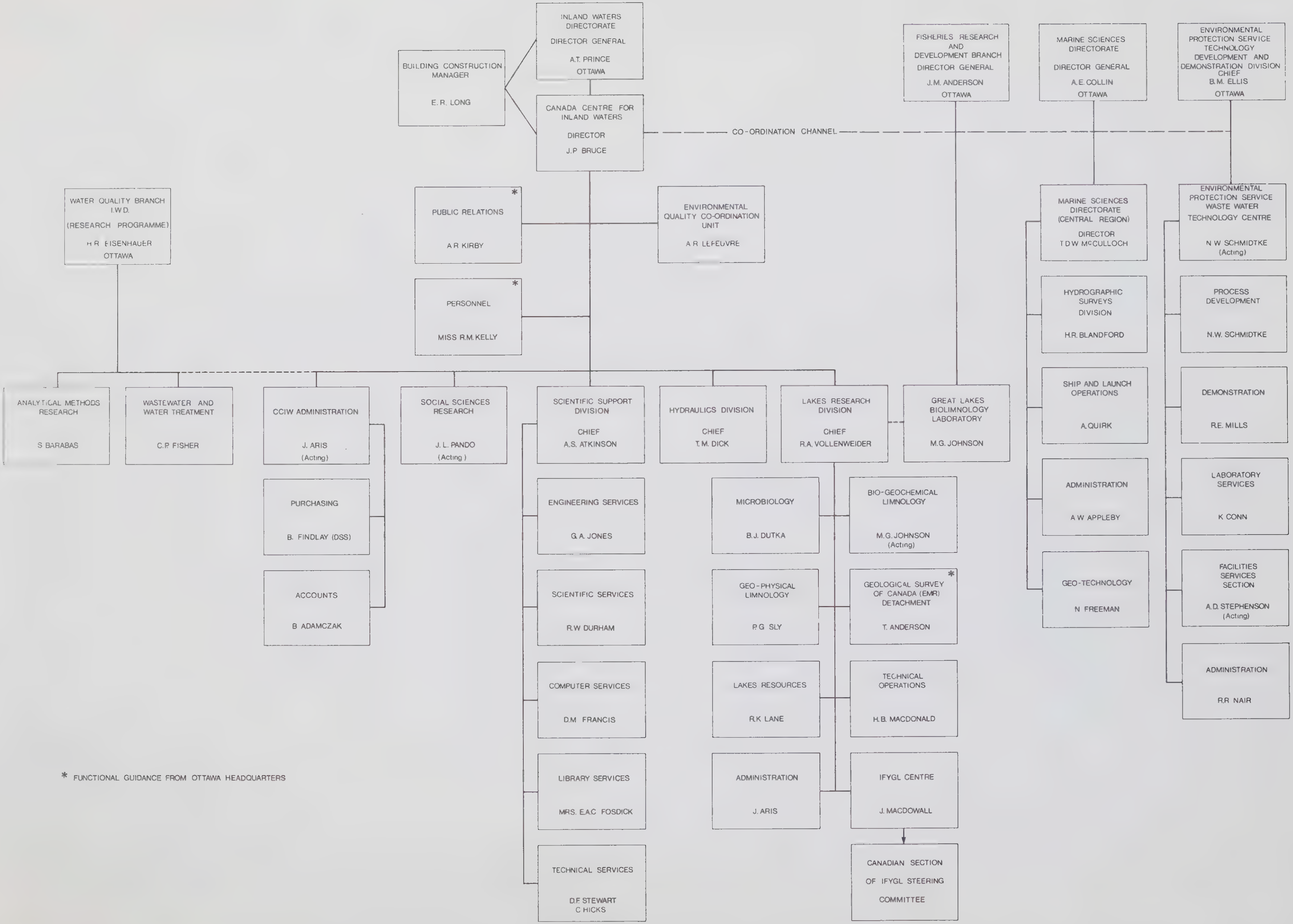
Environment Canada
Environnement Canada

CANADA CENTRE FOR INLAND WATERS 1972

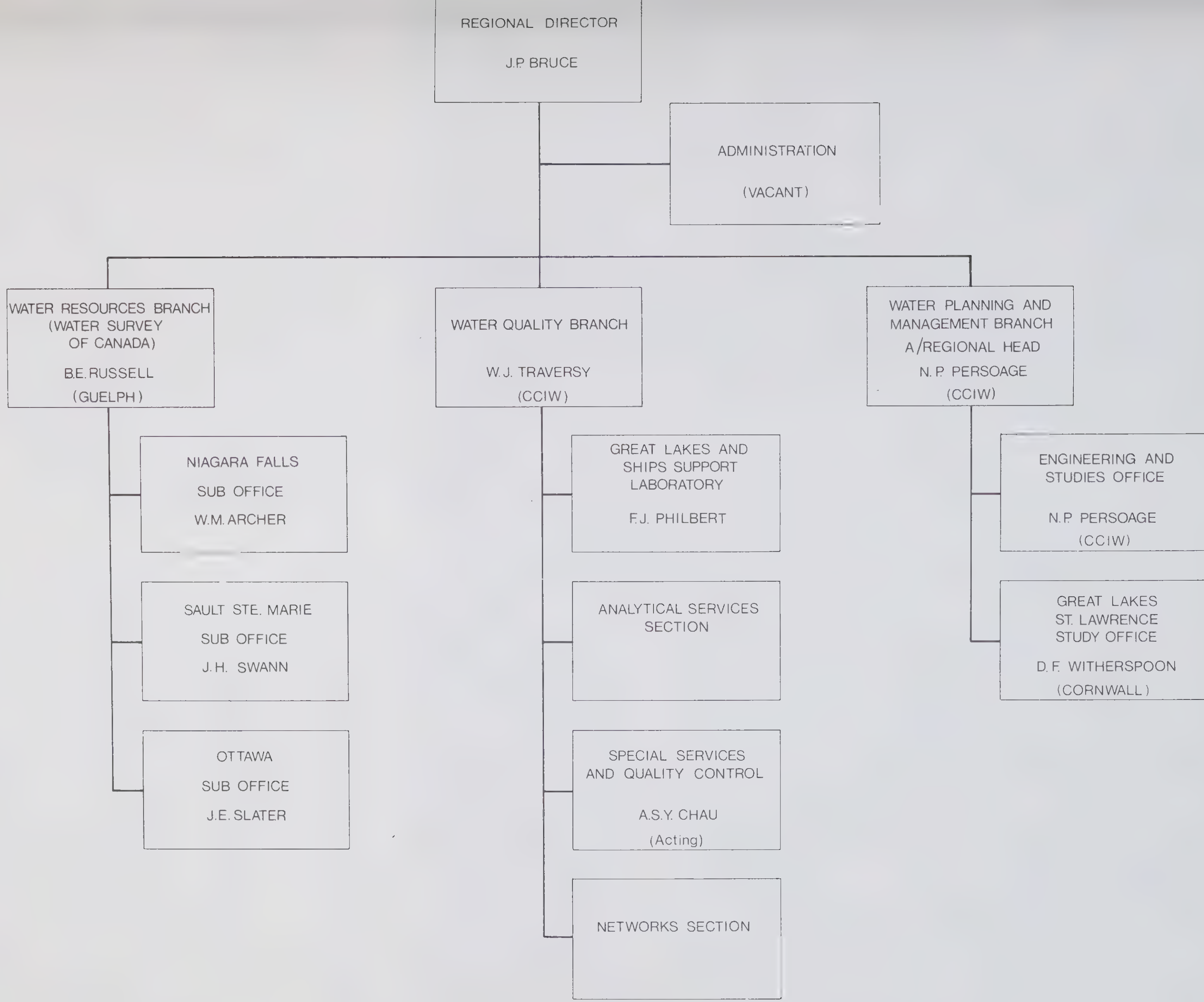
Cat. No.: EN39-172

Imprimerie Gauvin Limitée, Hull, P.Q.

Contents



CCIW Organization, December 31, 1972



Inland Waters Directorate, Ontario Region, December 31, 1972

Prime Minister Trudeau and President Nixon sign the Canada-U.S. Great Lakes Water Quality Agreement

Highlights

CANADA-U.S. AGREEMENT ON GREAT LAKES WATER QUALITY

A milestone in water quality control of the Great Lakes, and a major turning point in the work of CCIW, was reached April 15th with the signing by Prime Minister Trudeau and President Nixon of this Agreement, to which CCIW made many technical contributions. CCIW staff participated actively in the negotiations of the Agreement. The report on Project "Hypo"* concerning oxygen depletion in the bottom waters of central Lake Erie and subsequent nutrient budget evaluations significantly influenced design of the nutrient control program incorporated in the Agreement. In addition to the water quality objectives and pollution control programs required under the Agreement, a number of additional studies are called for which will involve extensive work by CCIW staff. These include establishment of specific water quality criteria for waste heat, radioactivity and host of toxic substances, criteria for characterizing polluted dredged materials, vessel waste treatment systems, studies to reduce costs of pollution control from combined storm and sanitary sewer systems, and studies designed to reduce chances of shipping accidents and improve Great Lakes contingency plan operations.

OFFICIAL OPENING OF CCIW BUILDINGS

The official opening of the Main Laboratory Building and the Water Quality Pilot Plant—Wastewater Technology Centre took place on May 5. The Honourable Jack Davis spoke at the opening to 300 visitors and guests and by closed circuit TV to staff members of CCIW. Mr. Davis and other visitors toured CCIW after the unveiling of the plaque, and saw displays set up by all components of the Centre illustrating their work. In a press conference Mr. Davis drew attention to the outstanding contributions made by Centre scientists and staff towards achieving the Great Lakes Water Quality Agreement with the United States and to phosphate control policies in Canada. A public Open House was held on the weekend following the official opening, which was attended by 9 - 10,000 citizens.

*Project Hypo Report (1972). "Project Hypo — An Intensive Study of the Lake Erie Central Basin Hypolimnion and Related Surface Water Phenomena", CCIW paper no. 6 (U.S. E.P.A. Technical Report TS-05-71-208-24). 182 pages.

SUPPORT OF INTERNATIONAL JOINT COMMISSION GREAT LAKES WATER QUALITY ACTIVITIES

The IJC was given primary responsibility for overseeing implementation of the international water quality agreement on the Great Lakes. To carry out the various provisions of the Agreement the Commission has established a number of Boards, Reference Groups and Task Forces. CCIW staff members have been appointed by IJC to each of these groups. In addition many staff members are actively participating in studies required under the Agreement and in monitoring and surveillance programs. R. A. Vollenweider (FRB-IWD) is a member of the Great Lakes Water Quality Board, chaired by A. T. Prince, Water Director-General, IWD; J. P. Bruce (IWD) is Canadian Chairman of the Research Advisory Board; R. K. Lane (IWD) is Canadian Chairman of the Upper Lakes Reference Group, responsible for major studies of Lakes Huron and Superior and for recommending on pollution control measures needed; M. G. Johnson (FRB) is Canadian Chairman and R. L. Thomas (IWD) member of the Land Drainage Reference Group undertaking a study of control of pollution from agricultural, forest and urban land drainage; and P. G. Sly (IWD) is a member of the Task Force on characterization and disposal of polluted dredged sediments. A. R. LeFeuvre and the staff of the Environmental Quality Coordination Unit are supplying the technical secretariat for the Canadian portions of all of these Boards and Reference Groups, which permits close coordination of activities and reports.

HYDROGRAPHIC CHARTING AND ASSOCIATED ACTIVITIES

Nineteen Seventy Two was an eventful year for the Central Region, Marine Sciences Directorate. For the first time, in response to urgent requests, the region mounted a major hydrographic survey in James Bay. This major move into the salt water was closely allied to an oceanographic study conducted solely by the regional organization.

A successful exchange of staff took place between Lake Survey Centre, NOAA, Detroit and the Hydrographic Service Division of the Region. It will be repeated and perhaps expanded in 1973.

The high lake levels on Lake Ontario in the summer and Lake Erie in the winter were responsible for consider-

able activity on the part of both Shore Property Studies and Hydrodynamics. In particular, the storm surge of mid-November at the western end of Lake Erie caused considerable public concern. The Region was able to respond immediately with an on-the-spot assessment of the damage. Better methods of ensuring accurate maximum level gauging records are still being sought. Meanwhile, the region has commenced studies, in conjunction with Inland Waters Directorate units located at the Centre, AES in Toronto and Ontario Hydro into the feasibility of issuing Storm Surge Forecasts.

A hydrographic survey of a portion of Georgian Bay was contracted out, a first for the region and for the Canadian Hydrographic Service nationally. The results of the survey are under assessment. If acceptable, it could mean the gradual development of a competent hydrographic survey industry — a requirement desirable from two stands — hydrographic surveying of Canadian waters can be mainly completed within a reasonable time frame without contemplating massive expansion of the Canadian Hydrographic Service — a new viable secondary industry would be created in Canada.

Our most northerly survey party was engaged in an international project in Nares Strait between Danish territory and Canadian territory. The positioning of Hans Island, one of the assignments of this group, has of course considerable significance in the race to establish sovereignty over the submerged land in the Strait.

The HAAPS system got a thorough and successful field test during the bathymetric survey of Lake Ontario, IFYGL Project 79F, and was completed in the late fall of 1972.

A new high speed cutter, CSS "Advent" came on regional strength in the dying days of 1972.

CANADA-ONTARIO AGREEMENT

The research provisions of the Canada-Ontario Agreement are designed to reduce construction and operating costs of extensive pollution control facilities for the Lower Great Lakes (Canada's share of responsibilities under the international agreement). Under this research program, 17 contracts were let to the private sector and universities for studies of waste treatment processes, including nutrient removal, and for treatment and disposal of chemical sludges. CCIW is managing these contracts on behalf of the Canada-Ontario Review Board which administers the agreement. The Environmental Protection Service — Wastewater Technology Centre at the Centre made excellent progress on studies under this agreement, of (1) use of quicklime for precipitation of phosphates on a pilot plant scale, (2) assessment of availability, costs and quality of chemicals in Ontario for phosphate removal, (3) chemical sludge characterization and land disposal of sludges and (4) effects of NTA on phosphate precipitation in treatment plants. Special research strategies were developed by the Technical Committee of the Review Board for land disposal of sludges from sewage plants with nutrient removal programs, and on combatting pollution from combined storm and sanitary sewer systems. J. P. Bruce (IWD) is federal co-chairman of the Technical Committee and E. E. Shannon (EPS) is technical secretary.

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES (IGYGL)

Six years of international planning culminated on 30 March, 1972, in the official opening at CCIW of the field program of the IFYGL, a major International Hydrological Decade program in the Lake Ontario Basin. The year 1972 has seen the execution of the international field program, largely in accord with plans published in the IFYGL Bulletin #2. Ontario agencies, universities and several components of Environment Canada are active participants.

Throughout the year Canadian and U.S. research ships, aircraft and lake towers were used together with 21 buoy systems to collect an unprecedented amount of information about a major lake; a program of a magnitude only possible through cooperative efforts of the two countries. International intercomparisons of observing and analytical techniques will be of great continuing value in all Great Lakes work. A special Decca "Navigator" position-fixing system was deployed under contract to the Marine Sciences Directorate, and the U.S. National Oceanographic and Atmospheric Administration.

The field operations phase will be completed in March, 1973. Preliminary results are available from several projects, in particular, assessments of terms in the energy budget, and of biological production of the lake. Among the many objectives of the program is a baseline assessment of the state of health of Lake Ontario prior to introduction of major pollution control measures under the Canada-U.S. Great Lakes Water Quality Agreement; assessment of temperature and energy budgets to assist in regulating waste heat discharges; much better water budget data and evaporation estimates to improve lake level and water supply forecasting; information to permit improved marine and shoreline weather forecasts; and a file of data needed to verify mathematical models of the biological-chemical-physical behaviour of a major lake system.

OKANAGAN BASIN STUDIES

Studies in chemical, geochemical and physical limnology of Okanagan Valley lakes were completed as inputs to the Canada-B.C. study under the Canada Water Act. The geochemical studies showed that phosphates were being effectively removed from the waters of the major lakes by formation of apatite, indicating that phosphate control programs should result in rapid, favourable changes in lake conditions. The CCIW Public Relations office provided extensive special assistance in the public participation aspects of the Okanagan studies.

DETERGENT PHOSPHATE REPLACEMENT EVALUATION

Extensive evaluation and monitoring programs on NTA (nitrilotriacetic acid) and sodium citrate were coordinated by CCIW to provide scientific advice to the Minister on environmental effects, and in coordination with the Department of National Health and Welfare on health aspects. The NTA evaluation program in 1972, following on from the 1971 studies, included assessments of NTA effects on sewage treatment plants (negligible), transport and mobilization of heavy metals by NTA, effects of NTA and NTA-metal complexes on aquatic organisms, microbiological degradation of NTA and nature of breakdown products, development of a special strain of NTA degrading bacteria, and predictions of environmental concentrations if additional use of NTA is permitted in detergents. An extensive study of effects on sewage treatment and effluent streams of use of various detergent formulations by families and staff of Gloucester Armed Forces Base was completed by EPS staff. A number of technical meetings were held with industry and with U.S. agencies on these matters. Summaries of study results and evaluations of the national need for reduction of phosphates were prepared for senior Departmental officials and the Minister. A Ministerial decision was made to limit phosphates in laundry detergents to 5% (as P_2O_5) effective January 1, 1973. No restrictions were placed on NTA use but a monitoring program to ensure that environmental and tap water NTA levels remain as low as predicted, was instituted by CCIW and Water Quality Branch, IWD.

TOXIC SUBSTANCE RESEARCH

Work continued on national surveys of importation, mining, manufacturing and industrial uses of substances potentially environmentally hazardous. Survey papers were completed on mercury, pesticides, lead, cadmium, beryllium and selenium, and are already proving valuable in pinpointing locations of potential environmental problems. Work is underway on antimony and chromium. Reconnaissance surveys were completed on PCB's (polychlorinated biphenyls), pesticides, and heavy metal concentrations in water, sediments and biota of the Lower Great Lakes. Information on PCB's was incorporated in comprehensive summaries for IJC prepared by CCIW staff, on PCB's in the Great Lakes, including input data from Canadian and U.S. sources. Studies on microbiological degradation and toxicity to algae of PCB's indicated which of the Aroclors which make up PCB's are least degradable and most harmful to algae. Further work was completed on mercury, fallout radioisotopes and other metals distributions, and on interactions of metals with sediments of Lakes Huron, St. Clair, Erie and Ontario. Contracted studies were completed on costs and effectiveness of various possible methods for removal of contaminated sediments. Work on natural "chelators" in lake waters suggests that their concentrations in lakes has a profound effect on the extent to which potentially toxic metals can affect biota in lake systems.

HYDRAULICS LABORATORY

The new hydraulics laboratory building and offices were occupied in early summer and work has proceeded on installing major equipment and facilities. By year's end the towing tank and carriage for calibration of current meters had been installed and work was proceeding on the major wind-wave flume, and the 1m and 2m sediment flumes.

ENVIRONMENTAL MONITORING INSTRUMENTATION

In support of all phases of the 1972 CCIW environmental-measurement program, a total of more than 60 major data-acquisition systems were provided for field use by Engineering Services. These data-gathering systems . . .mounted on a variety of platforms such as ships, moored buoys, towers, towed bodies, bottom structures, barges, etc. . . .were equipped with arrays of environmental sensors measuring effects ranging from solar-radiation to deepwater internal waves. More than 100 million effectively, independent environmental measurements and samples were taken with these systems, most of which after scientific analysis will be stored in the IFYGL Data Bank. More than $2 million worth of such instrumentation was deployed; the major proportion of which functioned reliably and within design tolerance. Despite hazards ranging from ice to major shore erosion, no instruments were lost in 1972.

MICROBIOLOGICAL AND ANALYTICAL METHODS

The analytical methods research section of Water Quality Branch was transferred from Ottawa to CCIW during the year and continued development work on methods for use in the national water quality network. Work was continued by the Microbiology Subdivision on development of better indicators than total coliform counts of microbiological — health aspects of water pollution. Sampling methods and preservation of samples are also under examination. In addition, the Microbiology Subdivision developed much more efficient oil-degrading bacteria than hitherto available, which will undergo field tests in 1973-4.

SHORELINE STUDIES

Marine Sciences Directorate continued updating of shoreline survey data on the Great Lakes, initiated originally by the Department of Public Works for IJC lake level studies. These data and charts have proven extremely valuable in 1972, along with Lakes Research Division studies of shore erosion, shoreline sediment characteristics and movements, and nearshore diffusion studies, to Conservation Authorities involved in developing shoreline land use

plans along Lake Ontario from east of Toronto to Grimsby.

ORGANIZATIONAL DEVELOPMENTS

Departmental Organization

A new departmental organization was announced in December 1972 which promises to affect the development of CCIW programs in 1973. Inland Waters Directorate becomes a part of a new Environmental Management Service, and Marine Sciences Directorate and Fisheries Research Board components of the Centre are now part of the Fisheries and Marine Service.

Inland Waters Directorate — Regional Organization

Transfer to CCIW of Ontario Region operational staff of Water Quality Branch and Water Planning and Management Branch was completed and J. P. Bruce was appointed as Regional Director, IWD, for Ontario.

Lakes Research Division

This Division was reorganized largely along "problem" lines rather than disciplinary lines, incorporating staff of both Inland Waters Directorate and Fisheries Research Board. However, towards the end of the year a new working arrangement was developed between IWD and FRB that necessitated some further organizational changes, to take place early in 1973.

Advisory Committee to CCIW

The Advisory Committee, under the Chairmanship of Prof. E. G. Pleva, University of Western Ontario, and its subcommittees continued to provide valuable advice on CCIW programs and on non-federal government use of CCIW facilities. At its meeting of November 7th the ACCC recommended some major changes in its method of operation and reporting procedures in the light of DOE and CCIW organizational changes and these are now under review in the Department.

Inland Waters Directorate Research Components

HYDRAULICS DIVISION

COMMISSION

The Hydraulics Division is responsible for the inception and implementation of a research programme in hydraulics, which is national in scope. To do this, research work is undertaken either directly or through contracts in fluid dynamics, sediment transportation, wave dynamics and ice and cold weather hydraulics. The Division is also responsible for the operation of a national calibration service for hydrometric instruments, particularly current meters. Meters are calibrated to suit the specifications of users.

The emphasis in the Hydraulics Division is to provide estimates of the changes in regime caused by developments and to seek the most efficacious practice and design methods wich will mitigate environmental changes.

ORGANIZATION AND MAJOR EQUIPMENT

Since the previous report, the Hydraulics Unit was organized as a Division with a strength for 1972 of 22 man-years. By the year end, all the positions were filled including the transfer of personnel from Calgary. The laboratory building was virtually completed in September enabling contractors to begin installation of major equipment.

By the end of December, the towing carriage was all but completed and the interim acceptance tests indicated that the primary specifications which follow were met.

Minimum Steady Velocity	0.5 cm per sec
Maximum Steady Velocity	600 cm per sec
Allowable variation in velocity	±1%

In the tests, the variation in the velocity was much less than 1% for all speed ranges.

Designs for the 1 meter x 26 meter long tilting flume and the 2 meter x 27 meter long sediment flume, sediment traps and sediment handling equipment were completed and installation began before the end of the year. All this equipment should be operational by the spring of 1973.

Designs and specifications were drawn up for a large and unique wind tunnel for the wind wave flume which is 4.5 meters wide by 114 meters s long. Design work was undertaken by Dilworth, Secord, Meagher and Associates to meet the specifications of the Division. Performance specifications for new experimental cold rooms were drawn up for construction in 1973. The rooms will have a minimum temperature of -35°C and will be 40 feet x 20 feet and 10 feet x 20 feet. It is expected these rooms will provide valuable experimental facilities for the study of ice and its effects on flowing water and structures.

HYDROMETRY UNIT

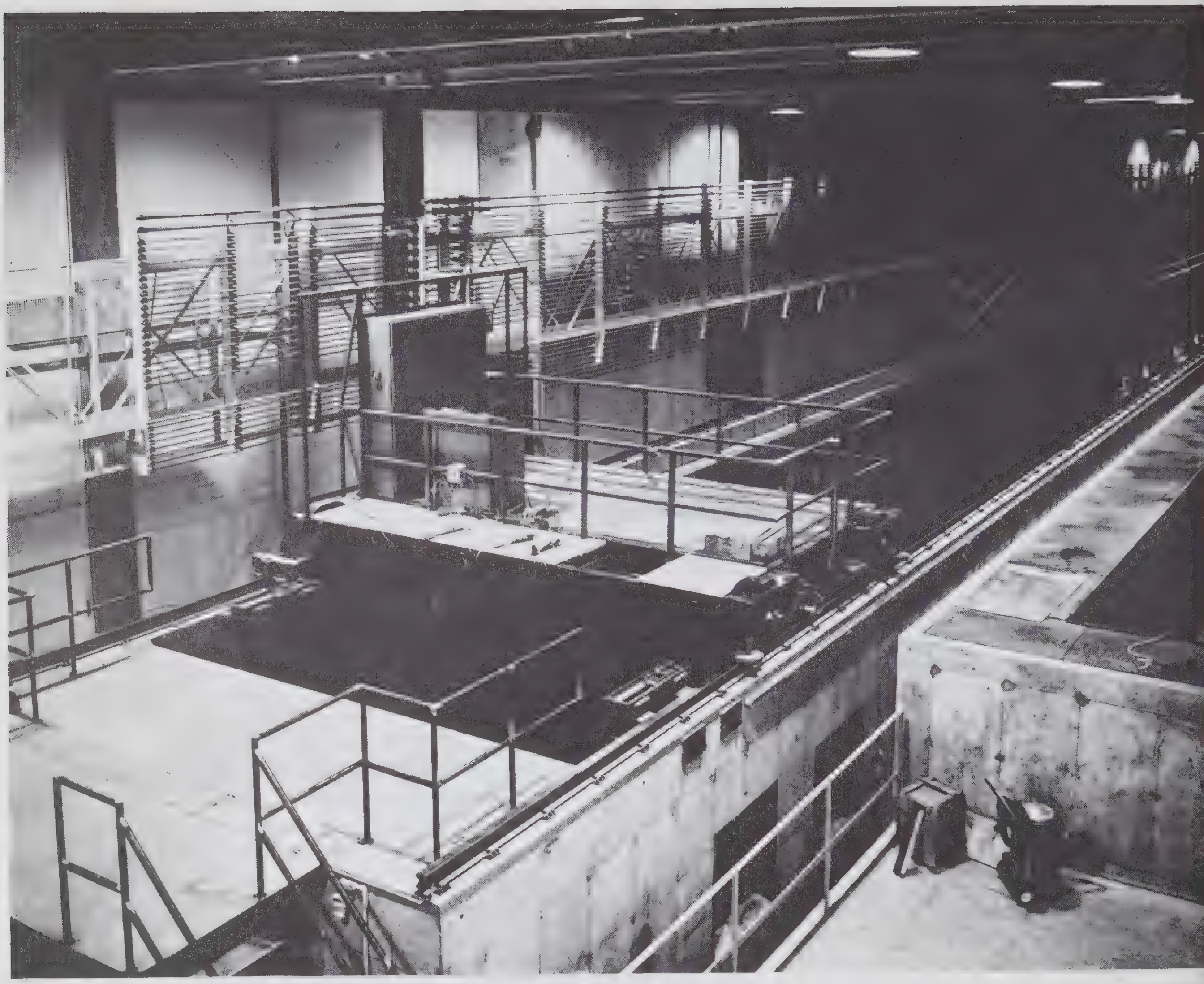
The year 1972 was devoted to the preparation, construction and installation of the towing carriage and its controls on the new 122-meter-long towing tank. The tank, carriage and its controls were completed in early December leaving only the data acquisition package to be installed in February 1973:

To complete the installation, plans were drawn up for a loading platform and skimming device for polishing the water surface. Operating procedures and policies for calibration have been prepared and computer programmes written to convert calibration data directly to calibration certificates. Methods for the calibrating of Plessey and Geodyne current meters were considered and discussions held with Engineering pertaining to their needs and schedules of current meter usage. For certain problems, a closed circuit television service was obtained so that visual data can be analyzed at leisure.

An on-going literature review of hydrometric literature is being undertaken to keep up to date with new instruments. Plans have been made to conduct experiments in the towing tank to study the effects of current meter suspension on performance and also to study the performance of different types of current meters. A separate series of tests will be run to ascertain the accuracies and performance of suspended sediment samplers.

TECHNICAL SERVICES UNIT

The Technical Services Unit is responsible for providing assistance to scientists and engineers of the Hydraulics Division with the construction, operation and analyses of their research projects. In addition to assigning technicians to projects, a "light" machine shop is provided to repair current meters and to make small parts for the day to day operation of the laboratory. An electronic shop was also



View of towing carriage and loading platform at end of 122-meter towing tank

organized to liaise with other electronic and electrical units at the Centre and repair and maintain electronic installations within the laboratory.

RESEARCH ACTIVITIES

A review was made of the mechanism of oxygen absorption into flowing waters and methods of predicting the reaeration rate. It was shown that none of the existing theoretical models and empirical equations satisfactorily predicted the reaeration rate over a wide range of flow conditions. Using dimensional analysis and by examining existing data, a new prediction was proposed. However, more data are required to completely verify this equation and experiments for such an investigation have been planned.

A conceptual design of a recurculating tilting flume 60 centimeters wide and 31 meters long was made for the study of the reaeration problem and the engineering design was completed by the C.C.I.W. Engineering Sub-division. Construction and installation of this flume is expected to be completed by the end of February 1973.

Research into the effect of bends on diffusion in rivers was initiated to continue work begun in the previous year. A computer programme was written for the numerical solution of the convective diffusion equation to investigate the effect of secondary currents on the spreading of a plume across a river. This numerical solution has been found to provide correct solutions for known simplified conditions.

A study of the exchange flow between Lake Ontario and Hamilton Harbour which was begun in 1971 has been continued in 1972. More field data on the thermal wedge was collected and compared with theoretical predictions. Exchange flow because of lake level fluctuations has been

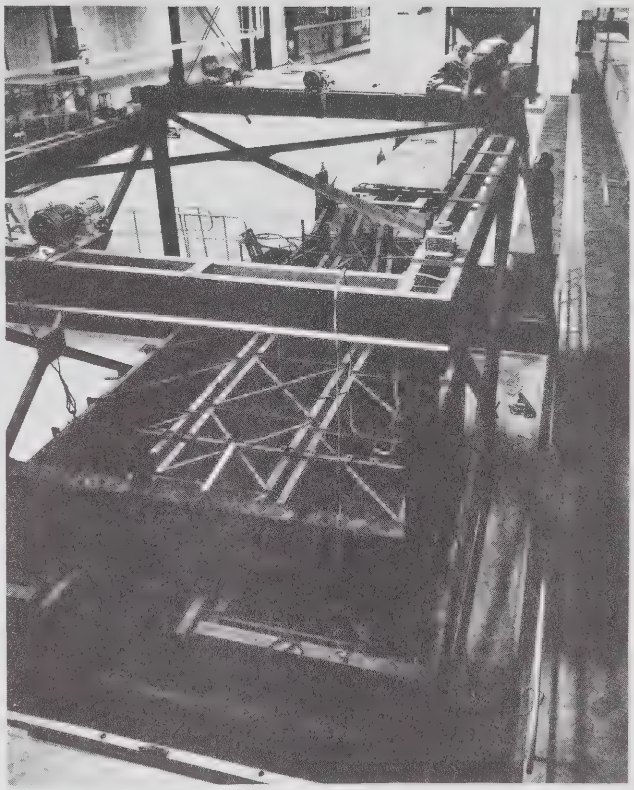
simulated by a mathematical model in the absence of stratification. Using water level data for Lake Ontario the fluctuations of water levels in Hamilton Harbour have been calculated and the exchange flow estimated. The factors which influence the exchange flow have been studied, especially the effect of landfilling operations. Results of these calculations were made available to Hamilton Region Conservation Authority and others.

A critical literature study examining the methods of abatement of pollution due to combined sewer overflows has been completed and published as an internal publication (*"Abatement of Pollution Due to Combined Sewer Overflows"*, Technical Bulletin No. 66). The report puts emphasis on those abatement schemes which may provide better and more economical protection for the environment than the conventional sewer separation. Several ideas for forther research were identified and some of them were submitted to the Technical Committee on the Canada/Ontario Agreement.

Design parameters for a wave machine were finalized and detailed calculations of geometric, kinematic and dynamic parameters were made available to potential suppliers. Tenders were called, evaluated and a contract was awarded. The design utilizes up to date technology to provide a fully programmable wave machine so that wave simulation in the wind wave flume will be as correct as possible.

A field study of shoaling waves was initiated in the summer of 1972. Simultaneous measurements and intercomparisons of deep and shallow water waves have been carried out. Many technical problems and difficulties have been encountered during the study. Since the climatic conditions suitable for the measurements occur on the average only one day per month, it will be necessary to continue the data collection for another year.

In the sediment transport field, a substantial engineering effort was expended in liaison, monitoring, specification preparation and supervision for the supply and installation phases of the sediment flumes including all the auxiliary equipment. A field review of existing and presently used sediment measurement technology was undertaken during the spring runoff. As a result, research into using hydrophone methods by which the acoustic noise generated by impacting bed particles will be correlated with the quantitative transport of sediments is being actively pursued. Field and laboratory studies will be undertaken in order to evaluate the hydrophone method.



Two-metre sediment transport flume and sediment traps under construction

Work on ice and cold phenomena was of necessity conducted out of doors. A project to measure the drag forces on an ice cover was undertaken on the Grand River near Hamilton where a number of survey stations were installed and the sections surveyed. Other studies on the production of frazil by waves were begun by the construction of a small recirculating flume which can be placed out of doors if required. The studies on ice and cold weather hydraulics problems are just beginning but it is expected this field will develop an importance especially in relation to northern development.

LAKES RESEARCH DIVISION

The objective of Lakes Research Division, within the broad terms of reference of the Department of the Environment and the Environmental Management Service, is to provide the government with the scientific knowledge needed for managing the freshwater resources stored in lakes in Canada. Accordingly, Lakes Research Division has two basic functions: (a) to perform basic research with a view to increasing scientific knowledge in the field of limnology, i.e., the science of lakes and lake behaviour or processes; (b) to deliver the scientific tools needed by management to solve present and future environmental problems related to lakes.

During 1972, a new organization of Lakes Research Division has become operative in order to better cope with the different requirements of the Division, and in addition,

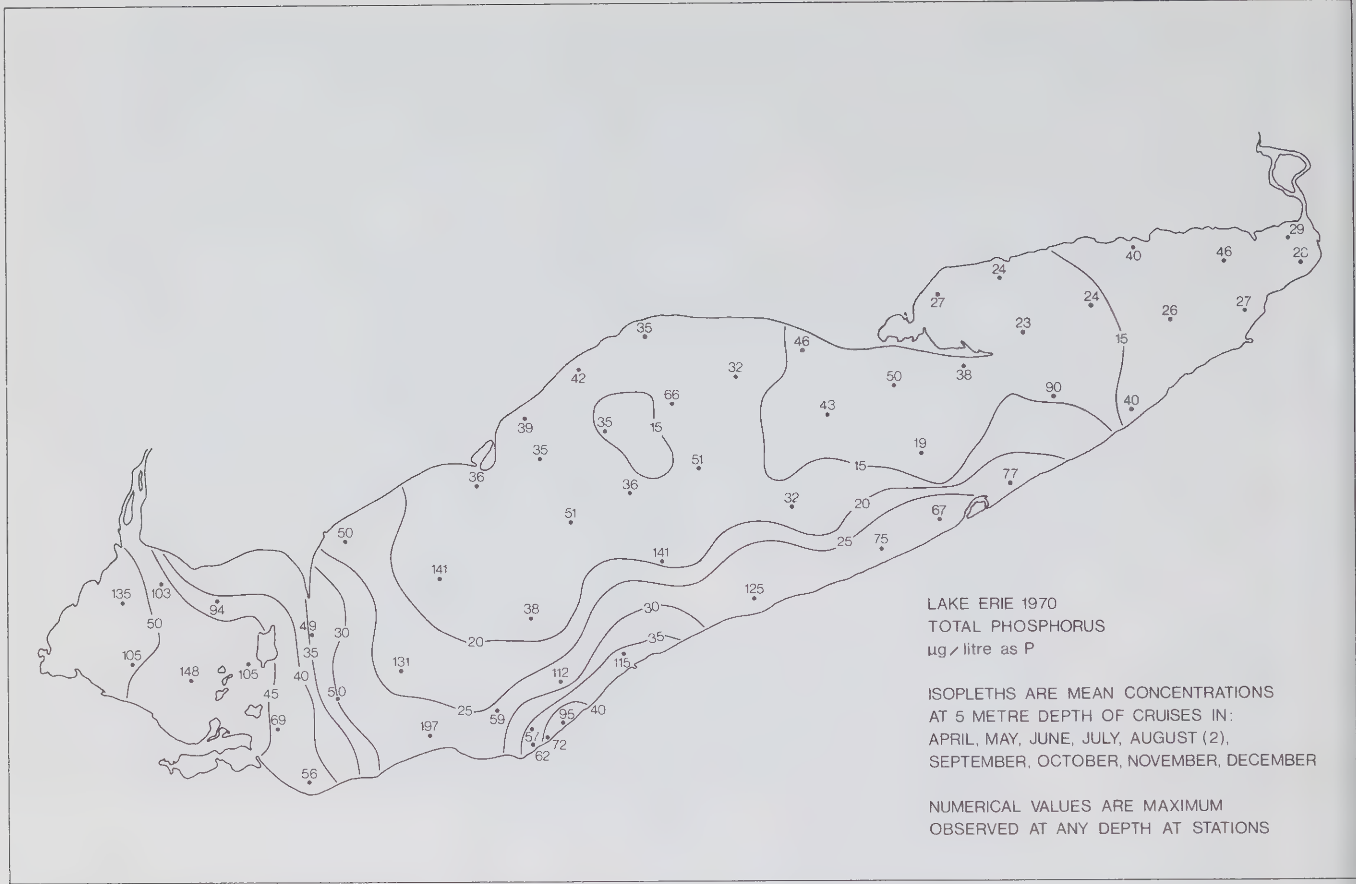


Figure 1. The average total phosphorous concentrations based upon the most recent year of significant record for each of the Great Lakes.

Figure 1 (cont.).

to separate more clearly the responsibilities for resource survey and description (Lakes Resources Subdivision) from process-oriented research (Geophysical Limnology Subdivision and Biogeochemical Limnology Subdivision). For various reasons the transition and adaptation to the new organization has been relatively slow but during the course of the year, benefits from the regrouping became apparent. However, toward the end of 1972 the program of Fisheries Research Board group was separated from Lakes Research Division and a new coordination arrangement developed for limnological research. During the year, Lakes Research Division assumed responsibility for microbiological research.

In the research areas of the 1972 field program, the Division has been heavily involved in the International Field Year for the Great Lakes (IFYGL). The Canadian contribution to the joint program with agencies of the United States has been most successful, resulting in a data return which was beyond expectation. High credit for this success has to be paid to the Operations Subdivision, as well as to the efforts of the Ships and Launches Division of the

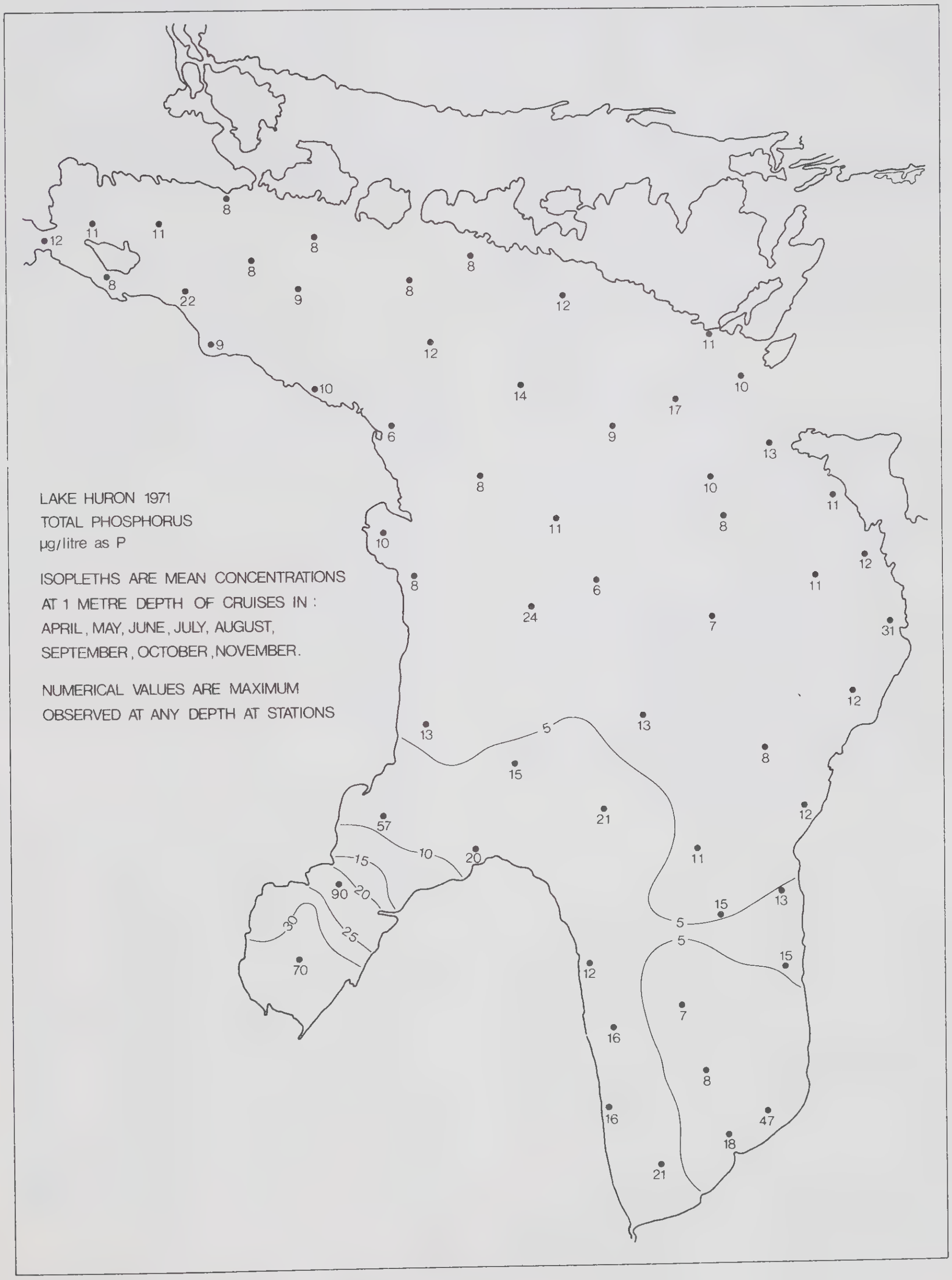


Figure 1 (cont.).

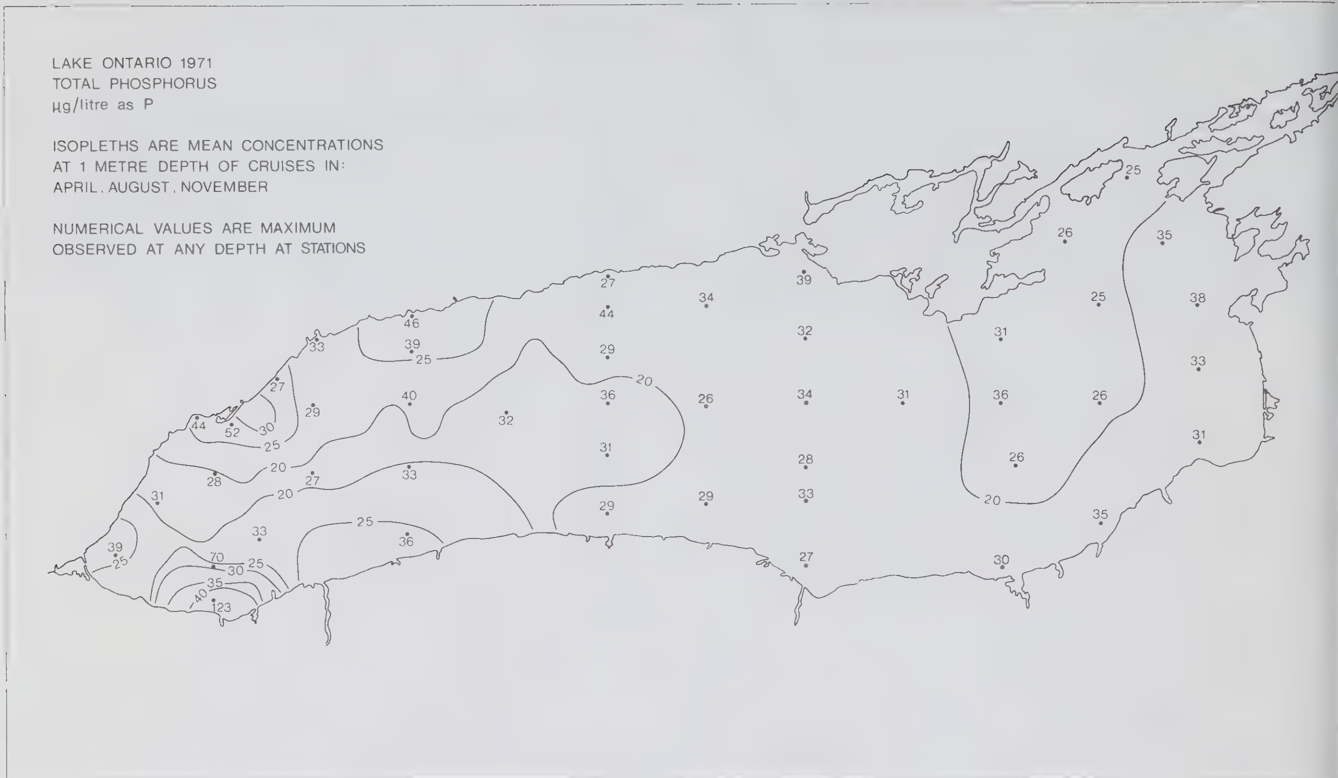


Figure 1 (cont.).

Marine Sciences Directorate—Central Region, and of the Scientific Support Division.

In addition to the continuing laboratory studies in the different Subdivisions, a large fraction of the staff has become heavily committed to program developments related to the Canada-U.S. Great Lakes Water Quality Agreement and to other departmental tasks. From a summary review, these activities in task forces, reference groups and committee of various sorts, has been estimated to take about one third of the Division's total activity.

LAKE RESOURCES SUBDIVISION

The functions of Lake Resources Subdivision are: lead responsibility and participation in multi-disciplinary descriptive research, and multi-agency, national and international limnological programs, and the development of descriptive techniques and methods; limnological data processing, in support of Lakes Research Division; and coordination and supervision of regional establishments of the Division.

These functions are carried out by three groups: the *Descriptive Limnology Section*, the *Data Processing and Display Unit*, and a detachment at the Freshwater Institute (Fisheries Research Board), Winnipeg. A second detachment, in the Pacific Region, was being formed at the close of the year.

Descriptive Limnology Section

Great Lakes Surveillance

Surveillance of the Great Lakes has been carried out during 1972 by water sampling from the ship cruises as listed in Tables 5 to 8. These cruises covered all of the international portion of the Great Lakes with the exception of Lake Superior and included some sampling in Upper Lake Michigan.

The chemical constituents of the waters of each of the lakes were studied with major emphasis on the nutrient elements. Calculations of the total quantities of nutrients contained in the lake at the times of cruises have been carried out. In some cases, these computations are done for different zones of a total lake. Contour maps have been prepared of the horizontal distribution of concentrations for different depth zones. A list of the total amounts of silica, nitrogen and phosphorous contained in Lake Huron is shown in Table 1.

Studies of Nutrients in the Great Lakes

During 1972, studies continued of major nutrients, particulate organic matter, and dissolved oxygen in the Great Lakes, using mainly the new CCIW data but also older information.

A preliminary study of nutrients in Lake Superior was completed as a preparation and stimulus for the Upper

Table 1. A list of total amounts of silica, nitrogen and phosphorus contained in Lake Huron.

Parameter		Whole Lake	Epilimnion	Mesolimnion	Hypolimnion
Silica	Quantity g. SiO_2 Mean Concentration $\mu g/1\ SiO_2$	3.085×10^{12} 1161	5.221×10^{11} 753	6.138×10^{11} 1014	1.949×10^{12} 1436
Nitrate & Nitrite	Quantity g.N Mean Concentration $\mu g/1$ N	5.864×10^{11} 221	1.203×10^{11} 173	1.334×10^{11} 1209	3.327×10^{11} 251
Phosphorus	Quantity g.P Mean Concentration $\mu g/1$ P	1.149×10^{10} 4.3			

Lakes IJC reference and also a comparative summary of nutrient conditions in Lakes Superior, Huron, Erie and Ontario was produced. An example of a treatment of these data is contained in Figure 2.

Particle Sedimentation in Lake Ontario

This project was carried out to gain some idea of the rate of settling and flux of organic particles in Lake Ontario. The equipment for measuring settling rates has finally been developed to the stage where reproducible results can be obtained as required. The net settling rates of particles at depths greater than 80 m were usually in the order of 1 meter day^{-1}. Perhaps the most significant finding was that the net settling (or movement) in the surface waters was frequently upward and not downward, due probably to phytoplankton and zooplankton migration. On July 19, 1972, the upward flux at the upper thermocline boundary was measured at 4.4 mg P m^{-2} day^{-1} which represented an increase of 5.5% per day in the phosphorus present in the epilimnion.

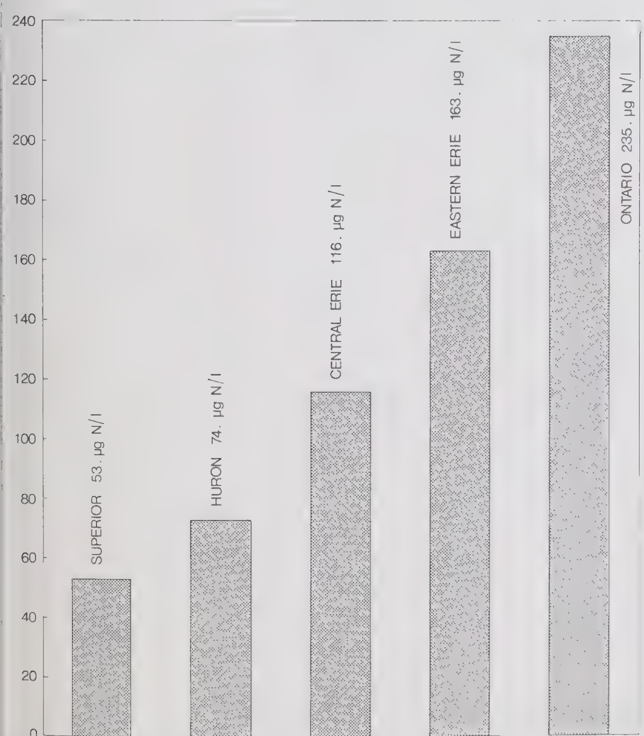


Figure 2. A comparative summary of nutrient conditions in Lakes Superior, Huron, Erie and Ontario. (Nitrate & ammonia) in surface waters, 1969-1971, winter maximum minus summer minimum.

Precipitation Chemistry

New snow sampling equipment was completed and installed at a number of stations during 1972. These new samplers are intended to overcome the sampling difficulties encountered in the winter by conventional samplers.

A computerized data storage and retrieval system was developed for the data as well as a number of basic statistical programs including a linear regression program, a histogram plot program and a t-test program. About 3 years of data have been accumulated on the Lake Ontario basin stations and about 2 years of data on the rest of the rain chemistry stations. Data for 1970 and 1971 from 7 stations in the Lake Ontario basin have been summarized and a report on the results has been completed. Table 2 lists some of the results reported in the summary. The annual deposit rate of nitrogen by rainfall indicates that in the Lake Ontario basin it is a significant if not a major source of nitrogen to the lake when compared to the total basin loading from other sources. For phosphorus it is a less significant source. The heavy metal deposition rates cannot be compared because there are no estimates available of the total basin loading of these parameters. However, the large ratio of rain water to lake water concentrations for many of the metals suggests that rainfall may be an important source of these metals, especially lead and zinc.

Recording Current Meter Data

Measurements: Most of the current flow measurements in 1972 were part of the IFYGL study of Lake Ontario. A total of approximately 200 months of data was obtained from sixteen moorings at the locations shown in Figure 3. Measurements in other lakes were limited to a monitoring

Table 2. Some results of the summary of rain chemistry station data.

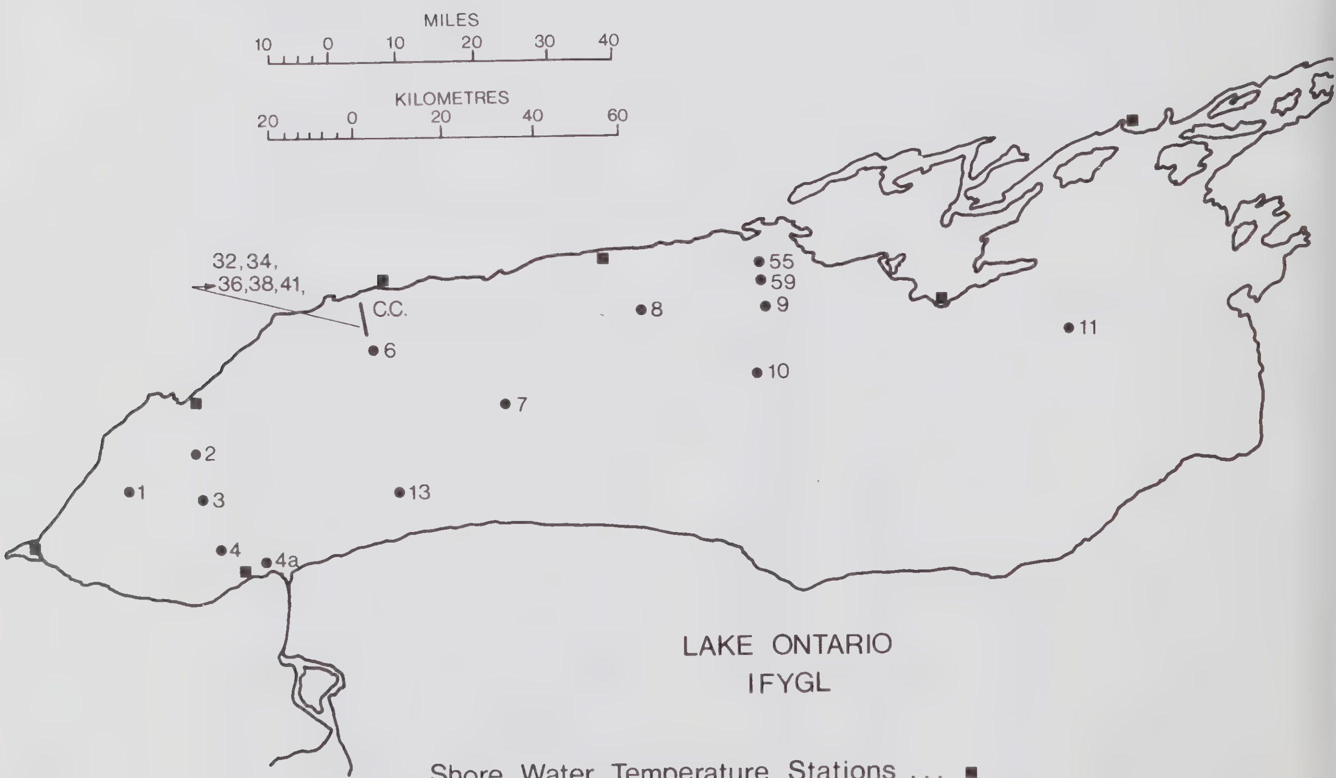
Parameter	Mean Deposition Rate $mg/m^2/mo.$	Mean Conc. mg/1	Median Conc. mg/1
Total Phosphorus P	2.94	0.058	0.027
Reactive Phosphate P	1.41	0.024	0.006
Nitrate + Nitrite N	55.16	1.53	1.20
Ammonia N	29.00	0.62	0.48
Sodium	106.12	2.69	1.82
Potassium	25.90	0.56	0.40
Calcium	216.26	5.04	4.40
Magnesium	34.16	0.82	0.70
Chloride	63.12	1.60	0.90
Sulphate SO_4	431.25	10.0	8.8
Lead	1.08	0.20	0.007
Iron	1.71	0.034	0.019
Zinc	4.20	0.080	0.066
Copper	0.33	0.006	0.005
Cadmium	0.07	0.001	0.001

of the flow in Main Channel, between Georgian Bay and Lake Huron.

Data Processing: The development of a new system for the reduction, editing and summarizing of current meter data was completed early in the year. The system was used for processing the IFYGL data and some of the data collected in previous years. In addition, limited data processing services were provided for MSD (CCIW) and MOE (Ontario).

Over-Lake Meteorological Measurements

A network of eleven meteorological measurement systems was operated on buoys at the locations shown in Figure O throughout the period April through December. A single system continues to operate at Station 3 through the winter. Meteorological measurements were obtained on a nearly continuous basis throughout the period. A record of data obtained (Fig. 4) shows that about 90 percent of possible measurements were successfully obtained.



Shore Water Temperature Stations ... ■
Met. Buoy ... 1, 2, 3, 4a, 6, 7, 8, 9, 10, 11, 13,
Micro Met. Study ... 4a,
E.R.T.S. Satellite Buoy ... 4a,
Diffusion Experiments ... C.C. —, 1, 2, 6, 10,
Thermistor Array ... 6, 9, 10, 11,
Current Meter Moorings ... 2, 3, 4, 6, 8, 9, 10, 11, 13, 32, 34, 36, 38, 41, 55, 59,

Figure 3. Map of meteorological measurements systems operating in Lake Ontario.

METEOROLOGICAL BUOY DATA FOR LAKE ONTARIO (IFYGL) 1972

STN.	POSSIBLE HRS. DATA	RECORDED HRS DATA	% RETURN	
1 –	5952	5254	88.3	WIND SPEED
	5952	5254	88.3	WIND DIR
	5952	5254	88.3	AIR TEMP
	5952	5254	88.3	REL HUMID
	5952	5254	88.3	WATER TEMP
2 –	5732	5447	95.0	WIND SPEED
	5732	5455	95.2	WIND DIR
	5732	5455	95.2	AIR TEMP
	5732	5287	92.2	REL HUMID
	5732	5455	95.2	WATER TEMP
3 –	5811	5091	87.8	WIND SPEED
	5811	5102	87.8	WIND DIR
	5811	5102	87.8	AIR TEMP
	5811	5102	87.8	REL HUMID
	5811	5102	87.8	WATER TEMP
	5787	5078	87.8	SOLAR RAD
	3188	2504	78.5	PRESSURE
4 –	5756	5490	95.4	WIND SPEED
	5756	5490	95.4	WIND DIR
	5756	5495	95.5	AIR TEMP
	5756	5495	95.5	REL HUMID
	5756	5495	95.5	WATER TEMP
(13) 5 –	5854	5205	88.9	WIND SPEED
	5854	5283	90.2	WIND DIR
	5854	5205	88.9	AIR TEMP
	5854	4871	83.2	REL HUMID
	5854	5562	95.0	WATER TEMP
6 –	5783	5031	87.0	WIND SPEED
	5783	4834	83.6	WIND DIR
	5783	5040	87.2	AIR TEMP
	5783	4834	83.6	REL HUMID
	5783	5040	87.2	WATER TEMP
7 –	5639	5598	99.3	WIND SPEED
	5639	5639	100	WIND DIR
	5639	5639	100	AIR TEMP
	5639	5639	100	REL HUMID
	5639	5639	100	WATER TEMP
	5639	5077	90.0	SOLAR RAD
	3894	3894	100	PRESSURE
8 –	5447	5447	100	WIND SPEED
	5447	5447	100	WIND DIR
	5447	5447	100	AIR TEMP
	5447	4973	91.3	REL HUMID
	5447	5447	100	WATER TEMP
9 –	5597	4919	87.9	WIND SPEED
	5597	4980	89.0	WIND DIR
	5597	4980	89.0	AIR TEMP
	5597	4815	86.0	REL HUMID
	5597	4980	89.0	WATER TEMP
10 –	5590	4728	84.6	WIND SPEED
	5590	4728	84.6	WIND DIR
	5590	4728	84.6	AIR TEMP
	5590	4728	84.6	REL HUMID
	5590	4728	84.6	WATER TEMP
	1677	555	33.1	SOLAR RAD
	2834	2376	83.8	PRESSURE
11 –	5561	5522	99.3	WIND SPEED
	5561	5522	99.3	WIND DIR
	5561	5561	100	AIR TEMP
	5561	5561	100	REL HUMID
	5561	5561	100	WATER TEMP
	336629	307,678	91.4	

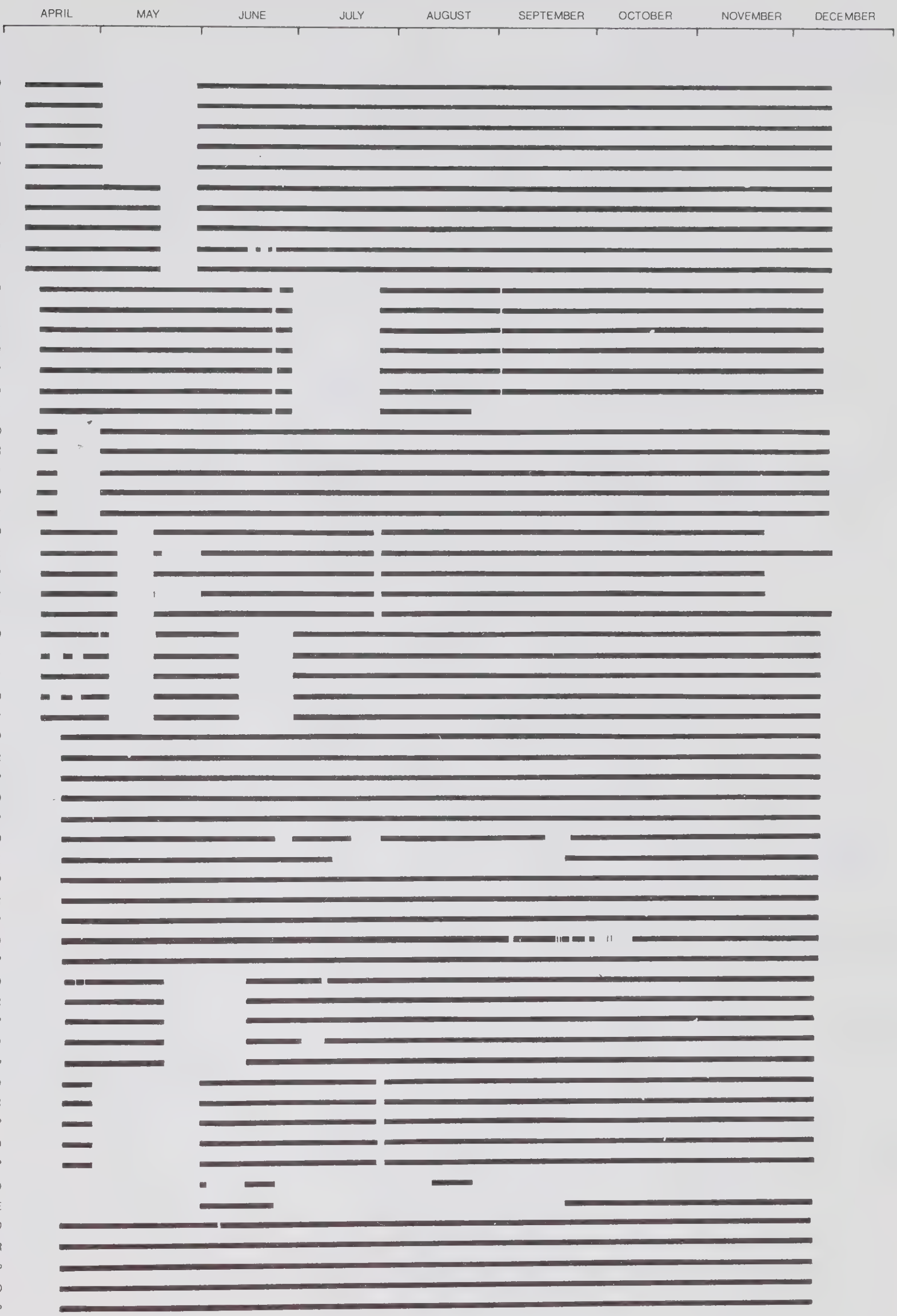


Figure 4. Record of meteorological measurement data.

The meteorological measurements are used in computation of the wind stress, evaporation and heat transfer. These values are then used in lake energy budget computations or as inputs to models of lake processes. A typical evaporation computation for the week of 19 – 25 April is shown as Figure 5.

Figure 5. A typical evaporation computation.

Lake Optical Studies

A study of the characteristic optical parameters of Lake Ontario was carried out during the Ontario Organic Particle Study (OOPS).

The parameters measured included: upwelling and downwelling light intensities, colour index, and attenuation coefficient as a function of depth and wavelength. The downwelling light intensity measurements were a vital input to the photosynthesis and carbon 14 assimilation studies.

A number of interesting correlations were obtained between the optical parameters (Fig. 6) and variations in the total particulate concentrations obtained from water quality measurements.

This was the first extensive optical study carried out by CCIW and the results obtained should have an important impact on future monitoring programs on the Great Lakes.

Shore Stations

Water temperature sensors were installed as a portion of the Atmospheric Environment Service system at seven stations around Lake Ontario (Figure 3). Three problems encountered which have been resolved are the mooring system, the electric field effect from thunderstorms, and radio frequency interference from radio beacons near some of the sites. One problem that is still presenting difficulty is the viability of the cable coming out of the water in the surf zone. There has been about a 70% return of usable data from all seven sites since their installations. A sample of the temperatures measured at the Burlington site is shown in Figure 7.

Remote Sensing

The 1972 remote sensing program was heavily involved with IFYGL (Table 3) on Lake Ontario. The main objectives were the continuation and improvement of the photographic program, and the conduct of surveys in support of limnological studies.

Time scale studies of lake surface thermal features were carried out using both low and high altitude overflights (Fig. 8). Previous evaluation of infrared line scanners, during the 1971 program, has resulted in better quantitative analysis of the imagery (Fig. 8).

Remote sensing operations in support of other programs included: support of dye diffusion studies in Lake of the Woods and Lake Ontario; support for the Oshawa Coastal Diffusion Study; support for the Air Water Interaction experiment at the Niagara test site.

Further work on the biological aspects of remote sensing were conducted on Lake Memphremagog in co-operation with McGill University, Department of Biology.

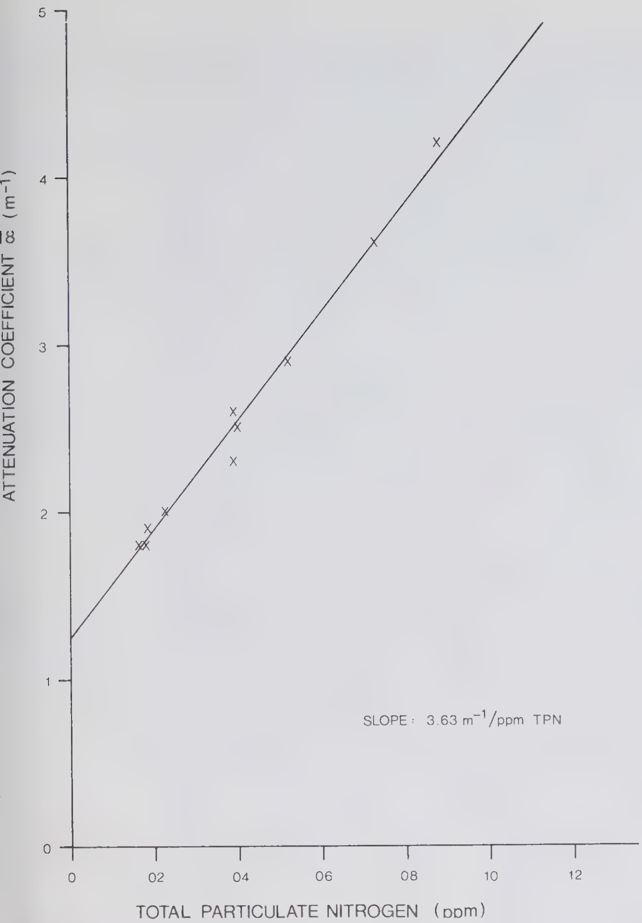


Figure 6. Attenuation coefficient of surface water determined with a wideband photometer versus total particulate nitrogen for the surface 10 metres.

On July 25, 1972, Earth Resources Technology Satellite — 1 was successfully launched into a geocentric polar orbit. The multi-spectral scanner aboard has functioned perfectly since launch, providing four-channel imagery of the earth's terrain on a synoptic basis. Imagery which has been observed thus far appears quite encouraging although imagery obtained over the Great Lakes since launch has suffered from extensive cloud cover, a situation which should alleviate as the winter season passes. Analysis of ERTS imagery at CCIW will continue to proceed along visual photointerpretative techniques. In addition automated photo-interpretation is planned for the near future utilizing digital magnetic tapes supplied through the Canada Center for Remote Sensing.

Data Retransmission via Satellite

A program has been initiated to assess the collection of scientific data via a satellite telemetry link. An application (to NASA) was approved to commence this program using the ERTS-1 satellite.

A small buoy was instrumented with air temperature, water temperature (using a Rosemount platinum resistance sensor) and a Hygrodynamics relative humidity sensor. This was matched with a data collection platform designed for use with ERTS-1. The buoy was moored off the Niagara Bar (Fig. 3) and operated during the period July 31 to December 10, 1972.

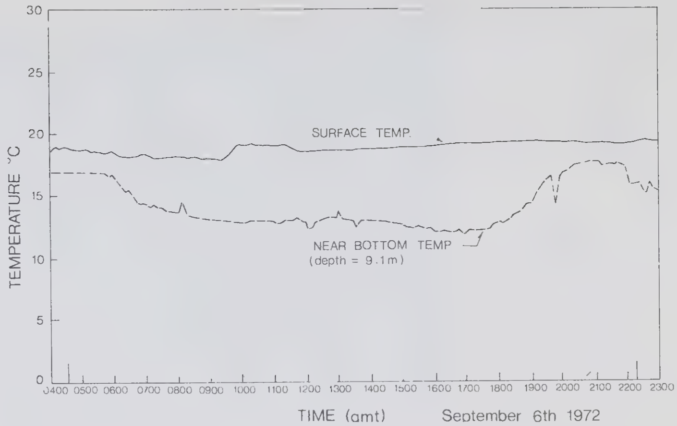


Figure 7. A graph of the temperatures measured by the water temperature sensors at the Burlington site.

The present system averages four transmissions per orbit and three orbits are received (on an average) every twelve hours. When comparing ground truth data with that received over the retransmission link, the errors were in order of 0.5%.

An "IRLS" (Interrogation, Recording and Locating System) experiment was a cooperative program between CCIW and the NASA-Lewis Research Centre, located in Cleveland, Ohio, involving a data collection platform (DCP) and a special constructed buoy, supplied by NASA-Lewis. The logistic support and data evaluation was carried out by CCIW.

The object of the experiment was to evaluate the positioning capabilities of the system to measure large scale surface currents, while transmitting actual data. During the period July to October, the buoy was released free-floating for three separate two week periods. For the first two periods the buoy anchored itself in shallow water (a small anchor was connected to the buoy, on fifty feet of line). During a severe storm (weekend of October 14), the buoy finally came ashore and was damaged. The experiment was then terminated. The number of successful interrogations during the study was in the order of 60%.

Data Processing and Display Unit

The Data Processing and Display Unit has the functions of filing, processing, running quality control on, and storage of, data collected by the Division, especially those data obtained by Technical Operations Subdivision. Eighty-five cruises for chemical and temperature surveys on Lake Ontario and eleven monitor cruises of the other Great Lakes were processed this year. Processed data has also

been provided to outside users, such as the Institute of Environmental Sciences and Engineering, University of Toronto; Biology Department of McMaster University; Department of Mechanical Engineering, University of Waterloo; and the H.G. Acres Consulting Engineers firm in Niagara Falls.

Computer programs were written to interpolate and grid data from a few observations and to determine average values of parameters retrieved from the "STAR" data file according to temperature and geographic locations. Two heat content computer programs, two editing programs for the bathythermograph nine point digitization and a spectral analysis program were converted for use on the CDC 3300 computer.

Several programs were written for the Hewlett Packard digitizer, namely programs to digitize electronic bathythermographs at one metre intervals, to digitize hourly averages of analogue records of temperature shore stations, to digitize and calculate the integrals and first and second differentials of graphed profiles of any parameter.

The Summary Data Atlas of temperature data and oxygen concentration for Lake Ontario and Lake Erie was essentially completed at the end of the year and will be published in early 1973.

Additional assistance has been provided to the Physical Limnology Section and the Descriptive Limnology Section in the processing and displaying of data for their projects by

Table 3. Involvement of 1972 remote sensing program on Lake Ontario with IFYGL.

Project	Location	Dates	Sensors	Ground Truth Measurements
1. Thermal gradient temporal evolution	Oshawa Lake Ontario	5/10/72 5/18/72 5/19/72 8/21/72 8/25/72 9/27/72 9/28/72 10/2/72 10/4/72	Infrared scanner 8-14μ Infrared radiometer 9-11μ Photographic	Survey launch surface temperature and bathythermograph recordings
2. Synoptic mapping of thermal and dynamic structures of Lake Ontario	Lake Ontario Hamilton to Kingston	6/7/72 8/28/72 8/29/72 10/27/72	Infrared scanner 8-14μ Photographic	Surface temperature infrared radiometer 9-11μ underflight, meteorological moored buoys
3. Dye Diffusion				
a) Patch b) Continuous flow	Oshawa Area Lake Ontario	6/5/72 6/27/72 6/28/72	Photographic	Fluorometer measurement of dye concentration profiles, surface drogues
c) Plume	Lake of the Woods, Ontario	7/28/72 7/29/72 7/31/72 8/1/72 8/3/72 8/4/72	Photographic	Lake current profiles, surface waves, winds, bathythermograph recordings
4. Experimental Survey	North Shoreline Lake Ontario	5/24/72 6/7/72	Photographic	Depth penetration Hydrographic charts
5. Algae and macrophyte concentrations and distributions	Lake of the Woods and Lake 227 Kenora	8/3/72	Photographic	Algae concentration Lake 227, FRB
	Lake Memphremagog, P.Q.	9/20/72	Photographic	Chlorophyll concent. McGill Biological Dept.
6. Atmospheric humidity profiles & lake surface radiometric temperature	Lake Ontario Niagara-on-the-Lake	5/25/72 5/26/72 6/16/72 10/10/72 10/12/72 10/13/72	Infrared radiometers 8-14μ and 19-11μ, air temperature, dew point temperature	Fixed tower surface water and air temp, dew point and winds

Figure 8. Infrared scanner mosaic and analysis of the imagery.

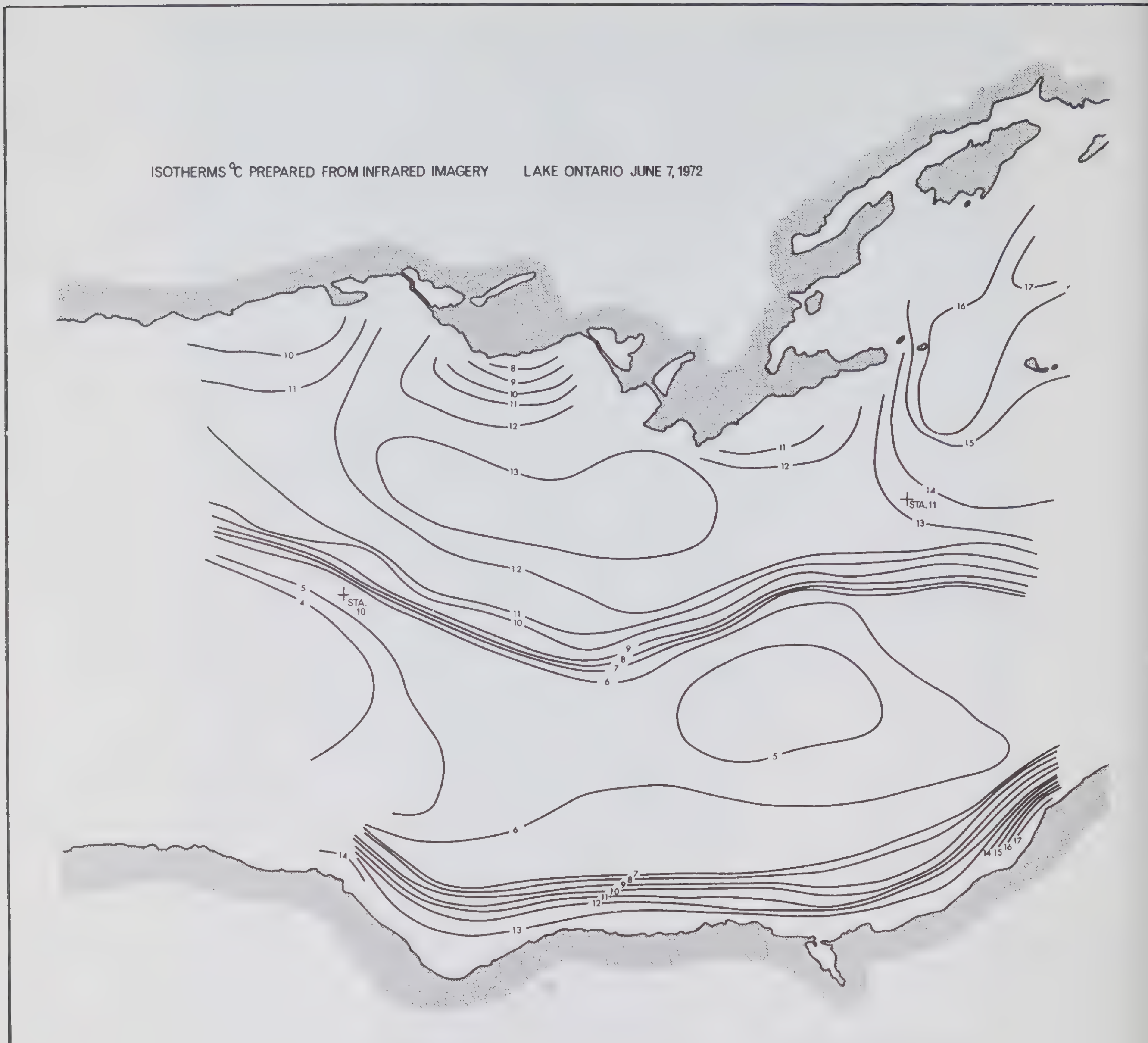


Figure 8 (Cont.)

processing data input to computer programs and analysis, correcting and displaying output. Some of the projects involved are:

1. Hydrodynamical modelling
2. Energetics
3. Heat content of Lake Ontario
4. Energy flux computations of Lake Ontario
5. Lake Erie nutrient data analysis
6. Nutrient studies of the Great Lakes

Regional Laboratories

Freshwater Institute Experimental Lakes Area

Work in physical limnology was conducted at the FRB Experimental Lakes Area near Kenora on the following aspects:

Lakewide circulation experiments at Rawson Lake, using radar-tracked drogues, produced an averaged velocity profile in the upper 6 metres. Initial results are consistent with a dependence between horizontal kinetic energy and the vertical distribution of Brunt-Vaisala frequency.

Detailed analyses of the spatial variation of both relative and absolute diffusion have resulted from dye experiments in selected lakes.

Near surface Eulerian current measurements were conducted in a small shallow lake. Comparisons of data with those from other lakes, in order to compare energy dissipation rates are being performed.

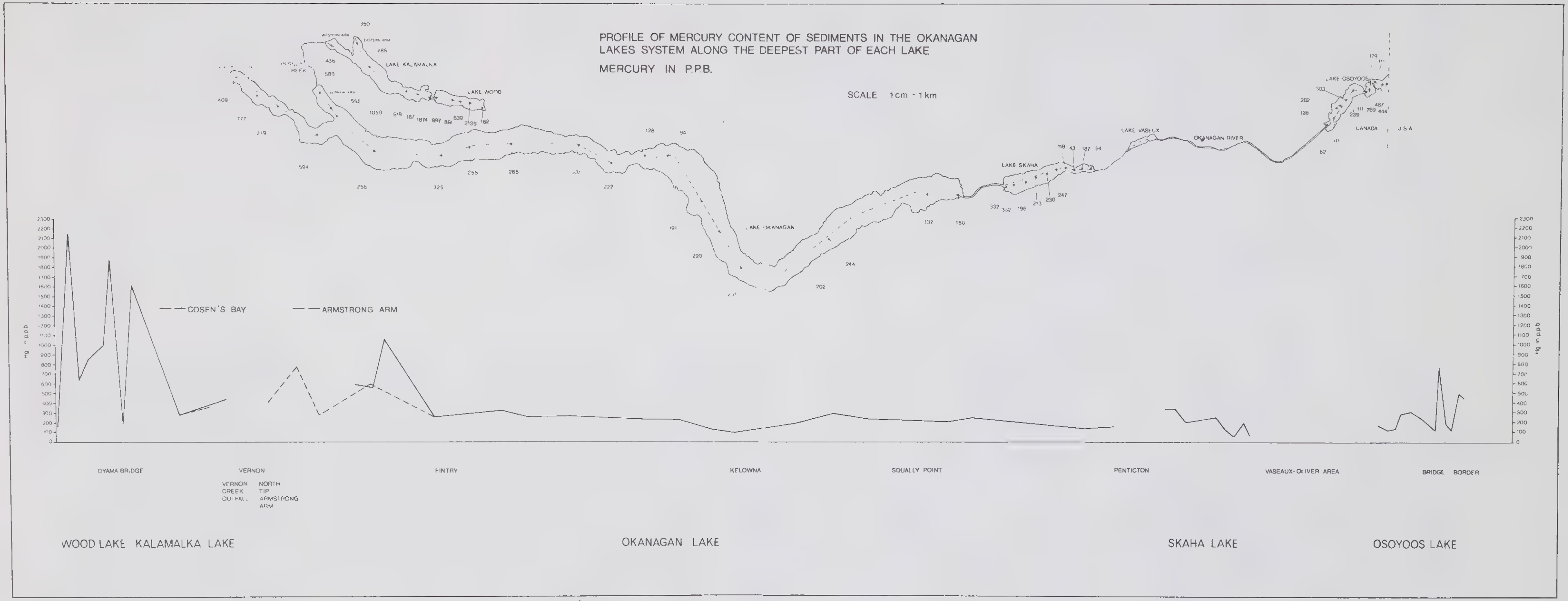


Figure 9. Profile of mercury content of sediments in the Okanagan Lakes system along the deepest part of each lake.

An electromagnetic EPCO current meter was used to measure horizontal and vertical velocity components. The horizontal component was dominated by quasi-periodic fluctuations correlated with Langmuir circulations. Attempts will be made to estimate the contribution of these to the momentum flux.

From continuous temperature measurements, determinations of energy concentrations at periods of 35 to 67 minutes have been related to the effects of bottom topography in Rawson Lake. Concentrations at 4.5 minutes are related to progressive Brunt-Vaisala waves. The latter were also recorded with amplitudes up to 2 metres from a triangular sensor array in a smaller lake.

A biogeochemical research program is also being organized at the Freshwater Institute, Winnipeg, where a laboratory is now being equipped for this purpose. The research planned for 1973 will consist largely of investigation of the role of clay minerals, humus, and clay-organic interactions in the budget and sediment-water interchange of phosphorus and iron, and its possible implications for eutrophication. Field work for the project will be performed at the Experimental Lakes area in western Ontario.

Okanagan Basin Study: Geological Investigations

The Geological Study of the federal-provincial Okanagan Basin Study (Task 121) was completed in June with the submission of a Final Report. The findings of the geological study were diverse, and resulted in the provision of a very large amount of basic data on the sedimentation processes in Okanagan, Wood, Kalamalka, Skaha, and Osoyoos Lakes. Highlights included the delineation of some areas in which the sediments appear to be enriched in mercury (Fig. 9) and the elucidation of the sediment phosphorus cycle in Skaha Lake. Wood, Okanagan and Osoyoos Lakes appear to have been undergoing eutrophic deterioration for much of the last century, but Skaha Lake started a sharp deterioration only 25 years ago with the onset of the sewage outfall from Penticton. Kalamalka Lake shows few signs of deterioration in the sediment record, and may have been somewhat "protected" from such a deterioration by its annual cycle of calcite precipitation. Although a "regional" study, this project was conducted out of CCIW by the Descriptive Limnology Section.

GEOPHYSICAL LIMNOLOGY SUBDIVISION

Components of the Limnogeology and Physical Limnology Sections of 1971 were brought together at the start of 1972, with the intention of improving the cross flow of activity and ideas, particularly as related to the nearshore zone and the interaction of lacustrine processes and shoreline materials. Although both sections carried forward pre-existing programs and commitments, such as those related to IFYGL and IJC references, steps were taken for joint planning of research activities, and the first developments of Physical and Geological Limnology programs were beginning to take effect at the end of the year.

Geolimnology

Regional Lake Sedimentology and Geochemistry

No large scale sampling program was initiated during the year and work has been restricted to the reduction of existing data, covering Lakes Ontario, Erie, and Huron. Major sediment distributions in Lake Huron showed considerable similarity to those recorded in Lake Ontario; in both these deepwater lakes, bathymetry is the major factor controlling particle size distribution. Sediment distribution data from Lake Erie suggests that response to wind/wave action and fetch is considerably more important. Major element analyses have been completed for Ontario, Erie, Huron and Lake St. Clair and are at present being prepared for publication. Trace metals (Hg, Pb, Cu, Zn, Ni, Co, Cr, Cd, Be, V, and Sr) have also been determined for Lake Ontario, Lake Erie and Lake St. Clair.

Nearshore Studies

During 1971 the nearshore inventory program in Lake Erie was extended westwards from Nanticoke to Port Burwell along the Canadian shore. (Figs. 10 and 11). The bottom sediment composition comprised 5% bedrock, 40% glacial material, and 55% unconsolidated material. Long Point Bay deposits varied from clean sands inshore to silts and muds offshore. Textural gradients alongshore suggest net westward transport towards the bay head, along both the north and south shores; probably source materials are the glacial drift exposed as bluffs and offshore in the north part of the bay, and the south shore spit deposits.

South of Long Point, the Long Point-Erie moraine is expressed as a major shoal which extends across the basin. Continuous sand deposits along the crest of this moraine appear to be derived from local reworking of underlying glacial drift and from erosion of glacial deposits on the shelf to the west.

West of the moraine, there is a broad offshore shelf of exposed glacial drift and derivative lag deposits, and a narrow shore slope composed of inshore sands and offshore muds. The sands are derived from the erosion of adjacent shore bluffs. Net drift is towards the east and acts as the supply for the accretion of Long Point. The survival of a band of shallow-water muds in what appears to be a zone of high energy has yet to be explained.

In Lake Ontario, a simple jetting procedure was used to establish the thickness and basal material of the Lake Ontario nearshore sediments at Burlington, Niagara, Toronto, Brighton and Wellington and to provide the basis for a coring program in 1973. Thickness gradients found were consistent with the net transport directions proposed for the basin. Maximum thickness measured was 18 metres at a site just north of the Burlington Canal entrance. Figures 12, 13 and 14 show the changes in the sedimentary

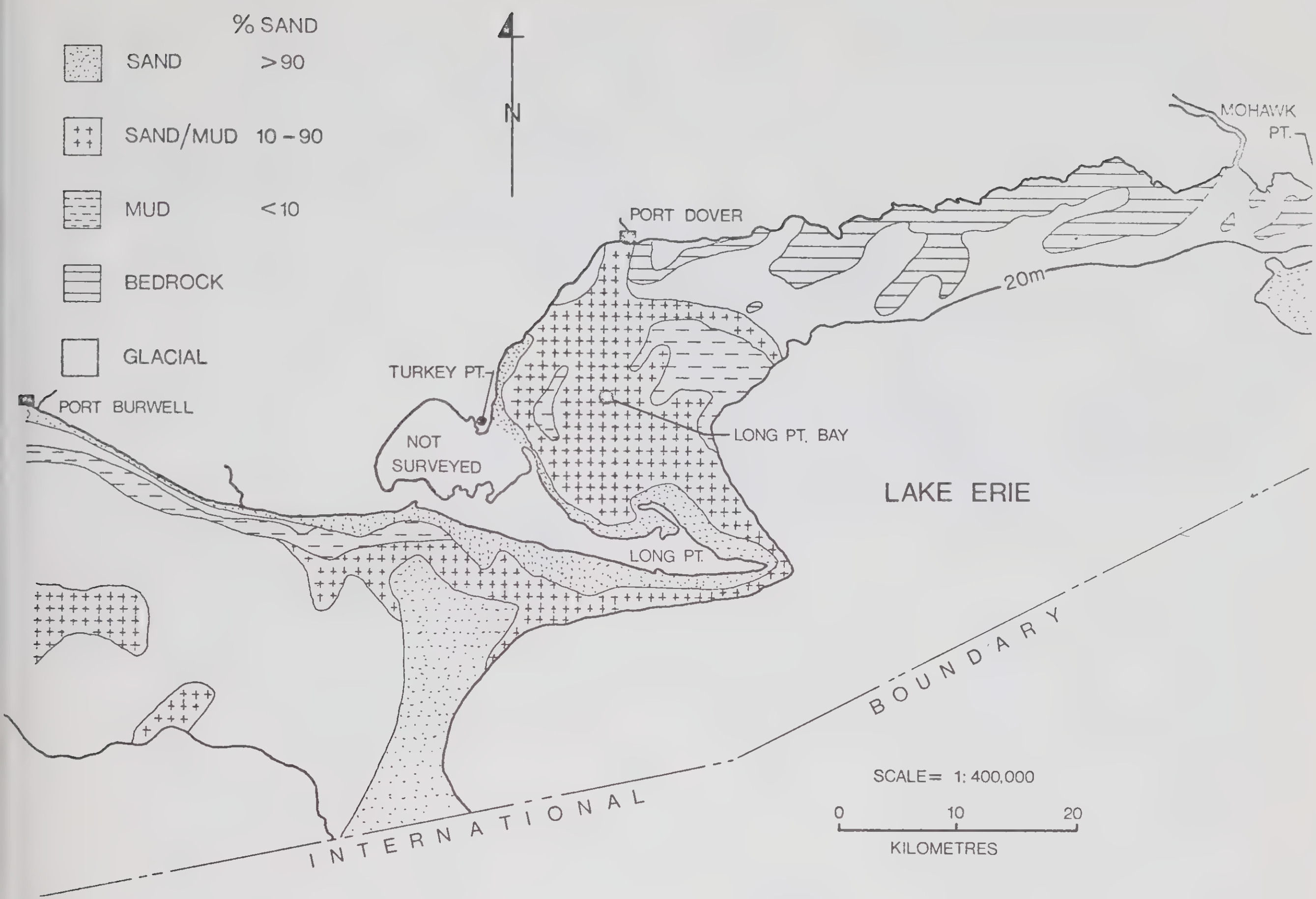


Figure 10. Nearshore inventory program, eastern Lake Erie.

ieposits of the Wellington Bay area of Lake Ontario, which ire evident from the comparison of Kindle's 1915/16 data nd that of CCIW obtained in 1971. Jetting data was used o complement the previous year's data and to confirm the mplied changes.

Project MOSES (Monitor Sediment Survey), which was lesigned to investigate the annual variations in sediment listributions in the nearshore zone off Burlington, has hown that the average depth of the survey area varied by .6 metres during the survey period. Of this, 0.6 metres was he result of water level changes; the remainder was due to ediment loss or gain in the area. Depth was greatest during he summer months, and least during the winter. There ppears to have been a net decrease in depth of 0.8 metres uring the survey year, which corresponds to a sediment nflux of approximately 50,000 cubic metres.

The overall average sediment texture varied by less han 5% during the survey year but significant changes did ccur in the distribution of the sand, silt and clay omponents. The tendency was for poor differentiation of and and sub-sand size material during the winter and spring nd good separation during the summer and fall.

Changes in textural pattern and depth appear to correlate with seasonal changes in wind direction and intensity. Shoaling and homogenization of texture corresponds to the period of most intense onshore storms; deepening and textural differentiation occurs during lower energy condition.

Figure 11. Vessel support for inventory program.

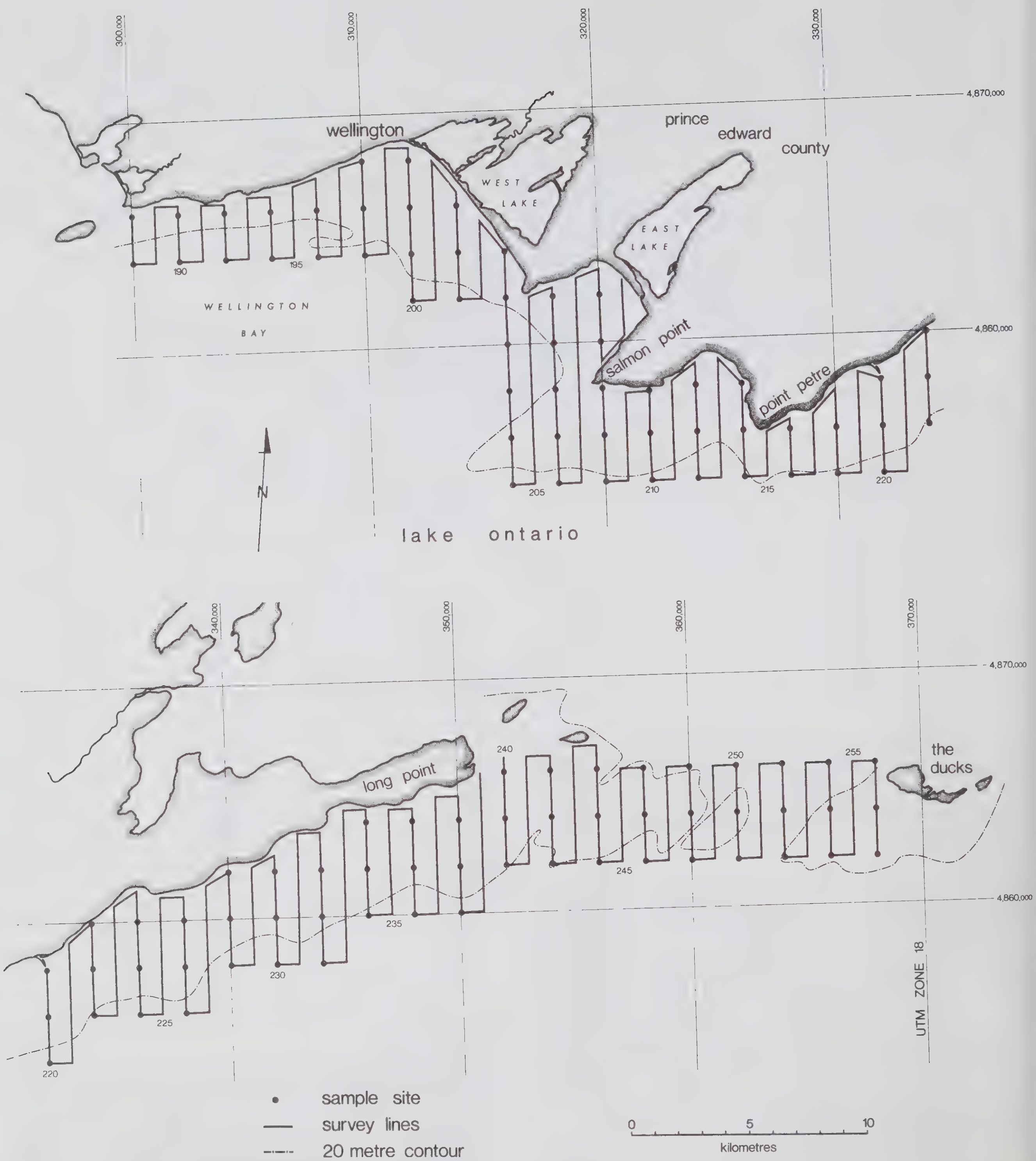


Figure 12. Map of sampling grid, Wellington Bay area, Lake Ontario.

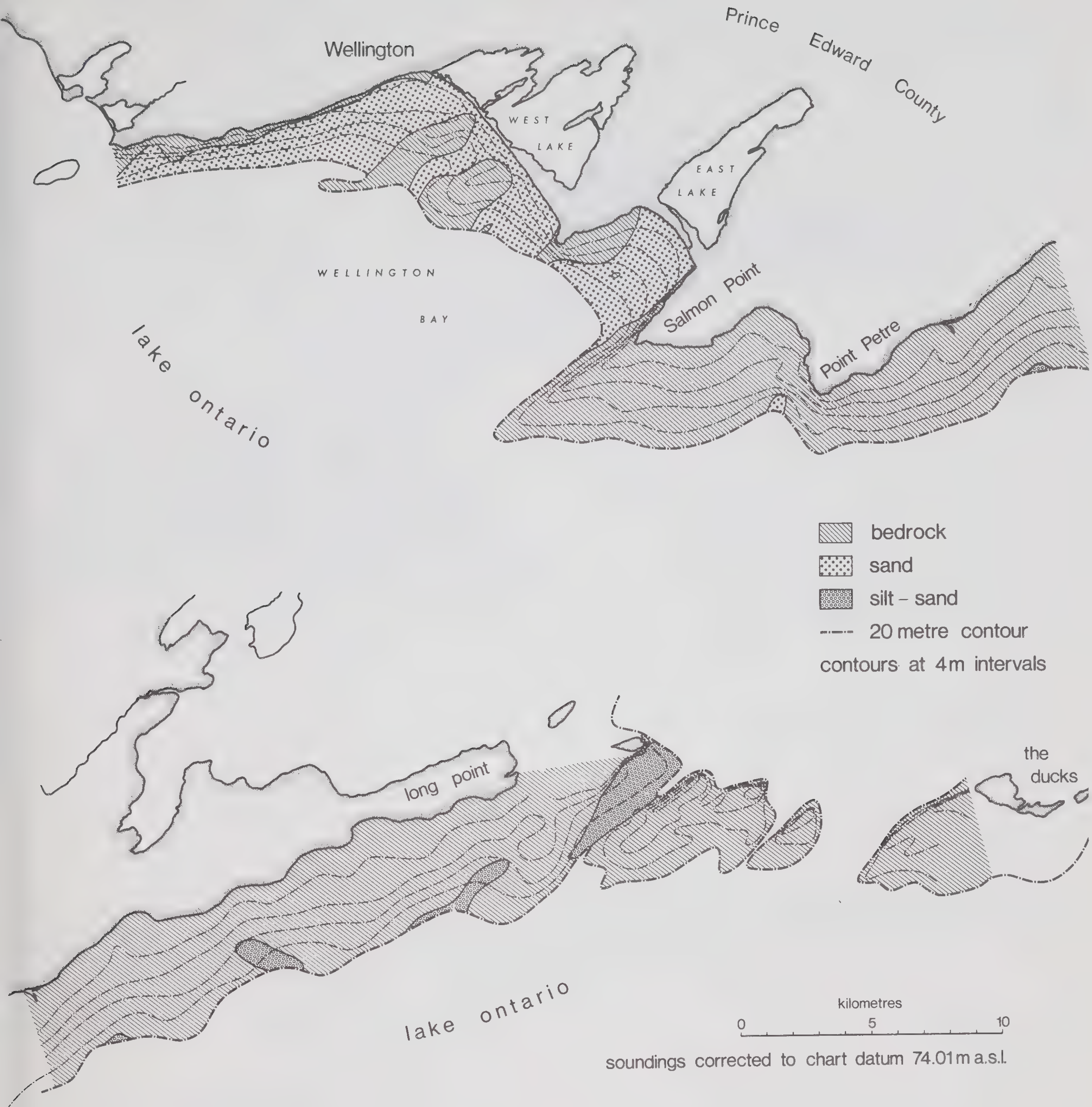


Figure 13. Map of sediment distribution, Wellington Bay area.

Tracer Studies

A pilot sediment tracing program was carried out in October 1972 offshore from Hamilton's Confederation Park, western Lake Ontario (Fig. 15). After an exhaustive literature review of tracing techniques used worldwide, it was decided to use a synthetic glass "sand" containing 3.4% of the element antimony (Sb). The field operations and sampling were supported by Scuba divers and analysis of the samples collected was carried out using neutron activation techniques. Results of the tracer experiment were complemented by shore-based monitoring of beach and wave-related parameters and confirmed that long-shore sediment movement is quite small when compared to movement perpendicular to the shoreline. At the tracer site, a strong net onshore movement predominated, probably reflecting the over-riding influence of storm waves from the east. The beach at this site was found to remain stable under all wave regimes.

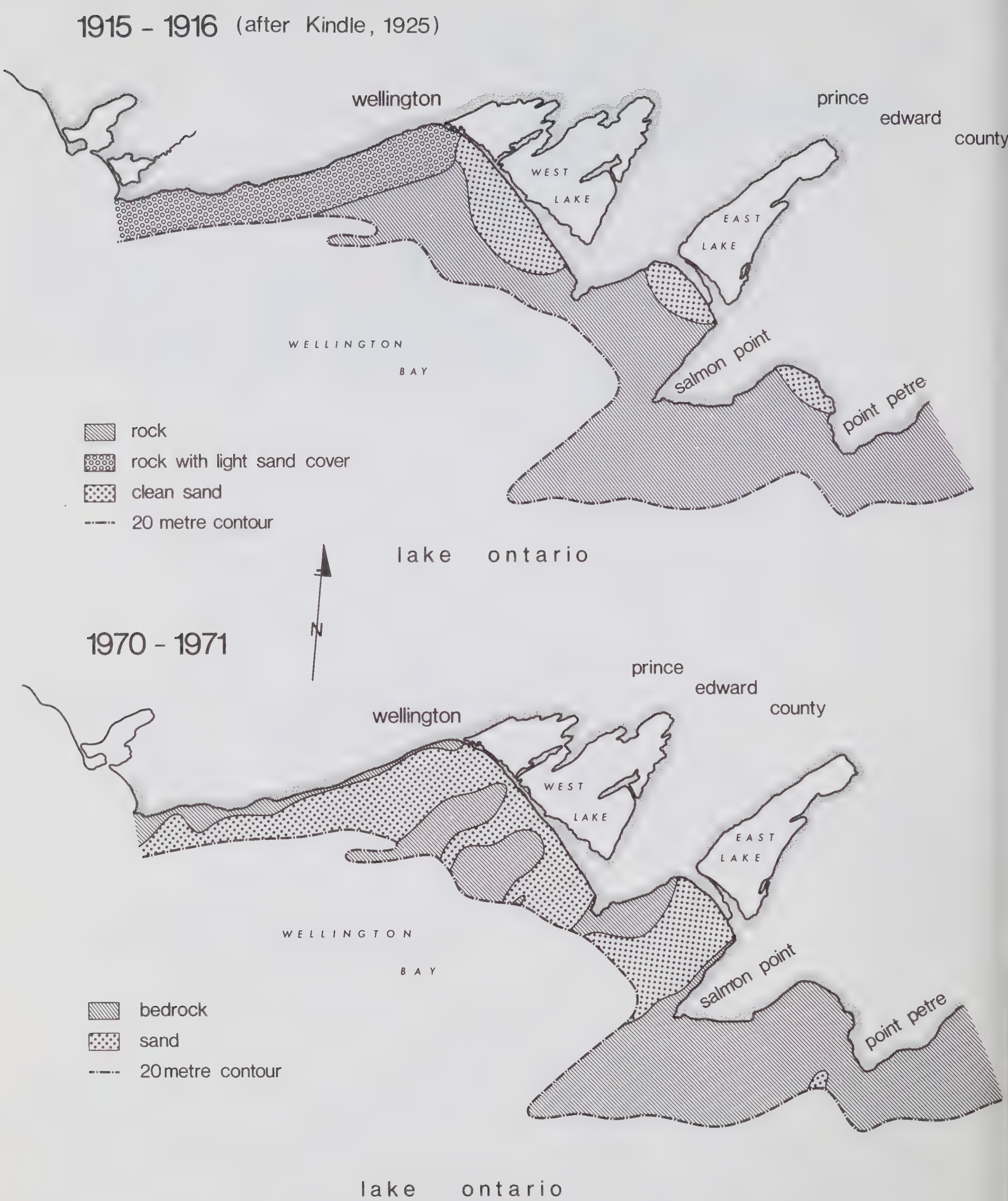


Figure 14. Changes in bottom sediments 1915-16 to 1971 Wellington Bay area.

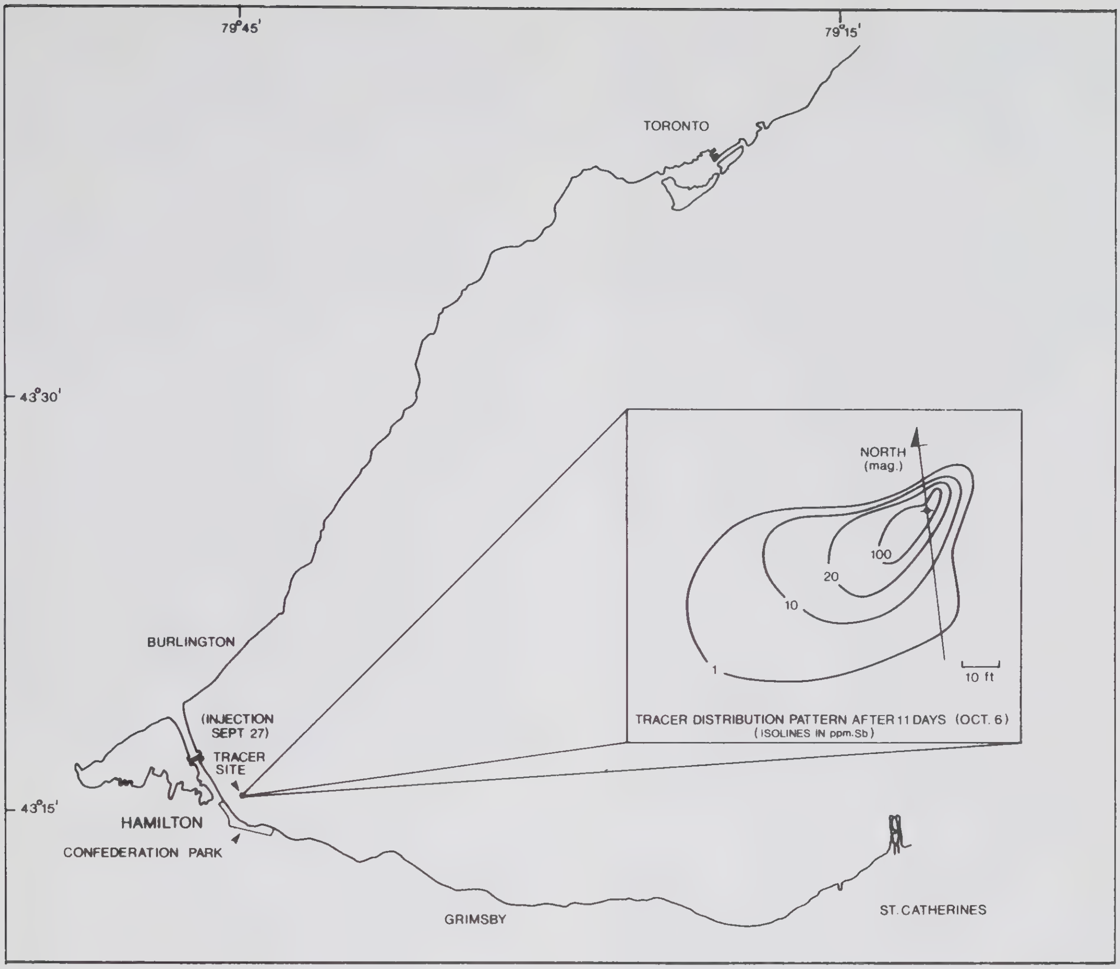


Figure 15. Sediment tracer experiments, western Lake Ontario, 1972.

Geophysical Studies

During the early part of the year an experimental, very shallow water, seismic reflection survey was run in conjunction with the University of Waterloo and the Atomic Energy Commission (Chalk River) at Perch Lake, Ontario. The results, however, were disappointing.

Further seismic surveys were run in cooperation with the GSC in the Mackenzie Delta-Beaufort Sea area, and to provide improved resolution of Lake Ontario "problem areas" in the eastern parts of the Rochester basin of Lake Ontario. Side scan sonar tests were completed in eastern Lake Ontario, after an extensive rebuilding of the existing equipment and installation of a new towed body. Assistance was also provided to the Earth Physics Branch for Heat Flow Studies in Lake Ontario (IFYGL).

Priority was given to the design and development of specialist geophysical equipment to be used in support of studies on recent sediment lithological and stratigraphic variations. This included a shallow underwater refraction system, an *in situ* and laboratory velocimeter, a core resistivity logger, an underwater resistivity profiler and an *in situ* resistivity probe. Much of this equipment is close to becoming operational.

Suspended Sediment Studies

These were restricted to a series of laboratory and test programs designed to evaluate the photo-extinction equipment for use in quantifying the low concentrations of suspended sediment from the Lake Systems. Drift in the order of 2-5% per 24 hours appeared to be related mainly to component quality; anomalous background levels observed during fluorometry tests have yet to be defined but are believed to have been related to impurities in the water supply used.

GSC (Geological Survey of Canada) – CCIW Activities

Palynological investigations were carried out on selected cores from the Great Lakes and from the Okanagan Valley lakes of British Columbia.

Pollen analyses were completed on a sediment core from South Georgian Bay to interpret the Quaternary

stratigraphy. Four pollen horizons provide a time-stratigraphic zonation of the sediments. One of these horizons, the spruce-pine transition (Ca. 9,500 years B.P. here), occurs at the contact between glaciolacustrine red clays and overlying grey silty clays. This transition dates these sediments and also the low-level stage of Georgian Bay, Lake Hough.

In Western Lake Huron piston cores have intersected peat, believed to have been deposited during low-level Lake Stanley (when Lake Huron drained northward). The spruce-pine transition occurs at the base of the peat.

Pollen analyses on piston cores collected by the Consumer's Gas Company from north-central, nearshore, Lake Erie, demonstrate a major hiatus, possibly amounting to 4000 years, between the glacial and post glacial sediments. This inferred hiatus presumably corresponds to an unconformity and lack of sedimentation during the low-level Early Lake Erie Phase (Ca. 12,500 years B.P.). However, preliminary pollen studies on cores collected in offshore areas imply uniform and continuous sedimentation.

A post-*Ambrosia* (related to European settlement and the advent of agriculture about 120 years ago,) decline in *Castenea* (chestnut) pollen, is being identified in six cores from Lakes Ontario and Erie. The *Castanea* decline correlates with the final die-out of chestnut trees about forty-five years ago.

Consistent pollen changes have been observed in sediments from the Okanagan Valley lakes, Okanagan, Wood, Kalamalka, Skaha and Osoyoos. These changes correspond to historically known changes in the flora and land use, such as the transition from cattle ranching to agriculture. This event took place about 1890 and hence serves as a convenient marker to date these sediments.

An extensive coring and sampling program was undertaken by the Consumer's Gas Company in Central Lake Erie in order to study and locate adequate bearing strata for jack-up drilling rigs. This study is of interest since it provides good quality cores of lake sediments (to bedrock) which were previously unavailable. Furthermore, this study will provide measurements and interpretations on engineering properties of the sediments with particular reference to their bearing capacity for offshore structures. A discussion of this program and interpretations and conclusions from preliminary data have been published in a report by Lewis, Wootton and Davis (Geological Survey, Report of Activities, Paper 73-1 PT.A., 1973).

Data Handling

During the early part of the year three sub-files designed for specific data handling were established. They correspond to shipboard sediment data (CCIW-SHIP), sedimentological laboratory data (CCIW-SEDPET), and geochemical data (CCIW-GEOCHEM). Geophysical and biotic data may be included in the near future.

Implementation of a merged file will be initiated early in 1973, in the form of a computer data file, for lake sediment data to be maintained at the Canada Centre for Inland Waters. Using the SAFRAS data file system, developed at the University of Western Ontario, the file will be compatible with similar geological data banks at the Geological Survey of Canada and the Ontario Department of Mines and Northern Affairs. The prime purpose of the file will be to serve as a continuing archive of sediment information for scientific and general use. However, the potential of such a computerized system of data records for data base management and analysis will greatly aid studies of regional scope.

Contract and Cooperative Studies

At the invitation of the University of Geneva a senior research staff member from the Section spent eight months on exchange, working on sedimentological and geochemical problems in Lake Geneva (Lac Leman). This exchange resulted in additional studies on the distribution of mercury in parts of the Rhone River system, in Lake Geneva, and also in selected isolated and alpine lakes. The effects of prevailing winds and associated rainfall were observed to be significant controlling factors in the atmospheric introduction of mercury into otherwise uncontaminated environments.

During the latter part of the year Section staff cooperated in programs of the Royal Ontario Museum designed to try to locate archeological evidence and remains of two important wooden sailing vessels lost off the Niagara Peninsula during the war of 1812. The program cooperation provided an excellent opportunity to test-evaluate modifications completed to the side scan sonar equipment. A number of targets were located in deep water offshore of the St. Catherines — Welland area, but subsequent follow-up with underwater television working at extreme depth were not confirmatory. At the present time it is believed that the targets so far located do not typify those of the search objective.

An extensive program of shoreline erosion studies was initiated jointly with the Civil Engineering Department of the University of Waterloo, and has been specifically designed to differentiate the control exerted by such factors as material composition, groundwater seepage, slope control, vegetation, wave forces, wave incidence, water level, and offshore bathymetry. It is hoped that results from this study, which is primarily concerned with the Niagara Shoreline of Lake Ontario, may be directly applied to other similar shoreline areas. Bearing in mind the impact of continuing high water levels in the Lower Great Lakes since predicted high levels during 1973, this information should be of considerable value in properly understanding the impact of high lake levels.

A contract with the Department of Geology of Lakehead University was extended into 1972, under terms similar to that existing during the previous year. Particular

attention was given to the shoreline and nearshore areas of the northshore of Lake Superior, and to the more isolated bays east of Thunder Bay, which had been neglected during previous surveys because of logistical problems. Evidence of environmental degradation appears to be significant only in very limited areas, such as around Marathon.

An extensive contract report was completed by H.G. Acres Limited (Niagara Falls, Ontario) on "The evaluation of procedures for recovering and decontaminating bottom sediments in the Lower Great Lakes." In this report details of the various aspects of dredging material processing and treatment, and cover by use of inert materials as they relate to the Great Lakes and similar environments were reviewed. Case history examples of studies undertaken at Placentia Bay (Newfoundland), Chedabucto Bay (Nova Scotia), New Jersey estuaries, Lake Washington, with the Great Lakes (by both U.S. and Canadian agencies), and from selected sites in Sweden, Germany, England, and Japan, were used to define the approaches which had been made to various sediment pollution problems such as oil spills, mercury contamination, and other industrial outputs; the success of each approach taken was appraised. In the light of Great Lakes problems, an example of a sediment pollution problem was chosen and then the various possible remedial approaches were evaluated in the light of present day technology and economics.

Some of the major points which arose from the report appear to be: (1) the need to lessen environmental impact by the use of improved and more efficient dredging technology; (2) the limited effectiveness of present technology in its ability to decontaminate or process polluted materials, particularly fines; (3) the inability of presently-available plant to effectively remove polluted materials once they have been allowed to settle out as a fine cover over a wide area.

It is expected that this report and its references will provide an important basis for much of the work necessary in proposing improvement to Great Lake dredging activities, and quality standards, as required by the IJC.

Physical Limnology

Physical or mechanical energy at all scales is ultimately responsible for the distribution of dissolved and suspended material within a lake. Studies of chemical and biological processes important in the life cycles of lakes must take into account the accompanying physical regime if full insight is to be gained into the dynamics of these processes. The role of the Physical Limnology Section is primarily one of research into basic physical processes affecting the distribution of energy and materials across the surface and within lakes.

The bias of the group as a whole is toward experimental work in the natural environment for which the Centre provides excellent facilities.

The greater part of the Section's work in 1972 was in support of the International Field Year for the Great Lakes (Fig. 16). A large body of field data has been successfully collected and is now being analysed.

Diffusion Experiments

Several diffusion experiments were carried out in 1972 in coastal waters, and offshore in both the epilimnion and hypolimnion of Lake Ontario. The basic technique consisted of injecting a marker dye (Rhodamine B) into the water either in a single blob or as a continuous stream, and then tracing, the time and space changes of the dye concentration field using fluorometers (for concentrations as low as 1 part dye to 10^{11} parts water) and aerial photography.

The nearshore experiments were of the continuous plume type with the dye being injected from a specially equipped raft. The depth of injection varied from the surface to 10 m and for these latter depths a bottom-moored diffusing apparatus was used (simulated outfall experiment). The dye concentrations in the resultant plume were measured from a 40-foot launch (C.S.L. AQUA) using a pump and continous flow-through fluorometer (launch-mounted) for each sampling level.

The offshore experiments were conducted from C.S.S. LIMNOS in collaboration with Professor G. Kullenberg of Copenhagen University and H. Westerberg of Goteborg University (see work supported under contract). Single patches of dye were released and the diffusing patch tracked using Kullenberg's *in situ* fluorometer. It was possible to continue some of these experiments through time and space scales as large as 80 hours and 15 km respectively.

The dye concentration measurements were complemented wherever possible with measurements of meteorological parameters, local current structure and thermal structure.

A preliminary analysis of the data in which effective horizontal eddy diffusivities were calculated as a function of the spatial scales, suggests that the diffusivities range from 10^2 to 10^6 cm^2/s in such a way that Richardson's "4/3 power law" dependence of eddy diffusivity upon spatial scale is approximately verified (Fig. 17).

The experiments in which dye was released in the thermocline zone are particularly revealing as to the complex" sheet and layer" structure of the thermocline. The dye was observed to spread within a narrowly-confined layer having the same density as the initial dye solution. The vertical position of this layer varied due to internal wave activity but could be identified from an examination of the thermal structure. Dye appeared to diffuse across the vertical boundaries of the layer where local current sheer is expected to be high (Woods, 1968). Further study of diffusion processes in a thermocline would greatly benefit

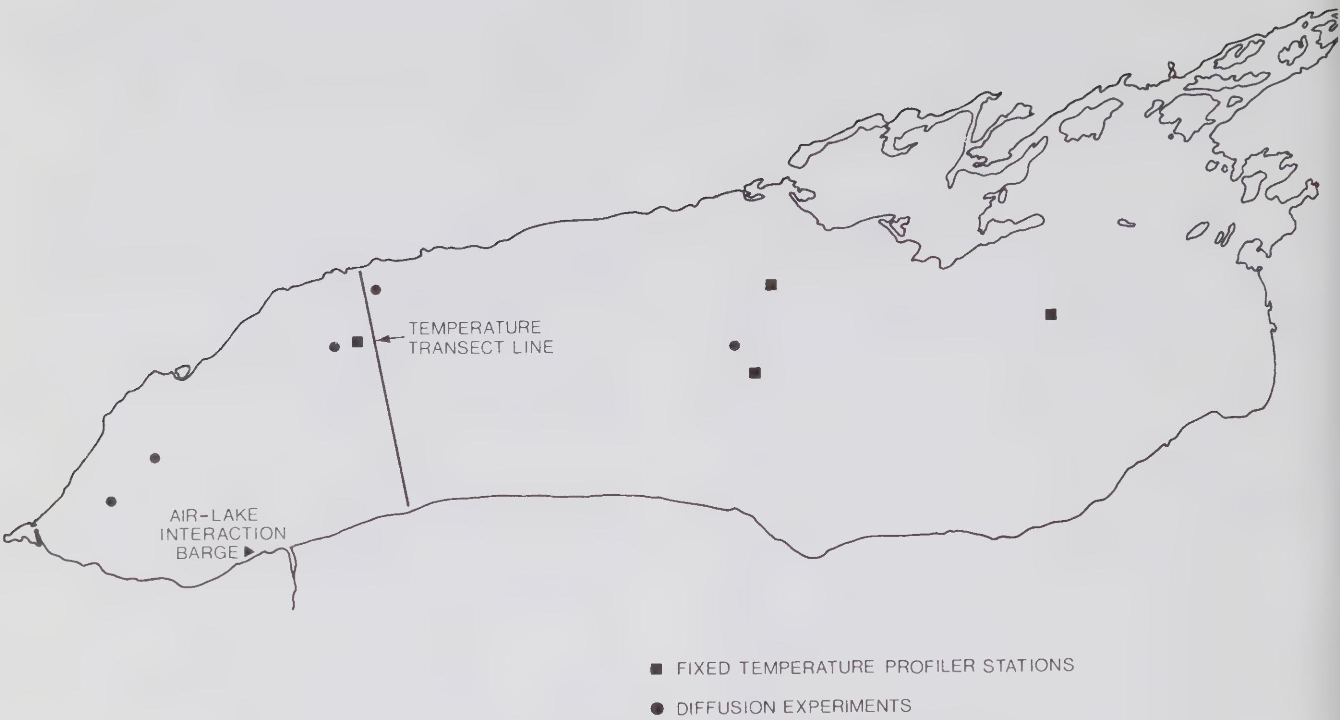


Figure 16. Map of Lake Ontario showing approximate locations of 1972 field operations of projects undertaken by the Physical Limnology Section.

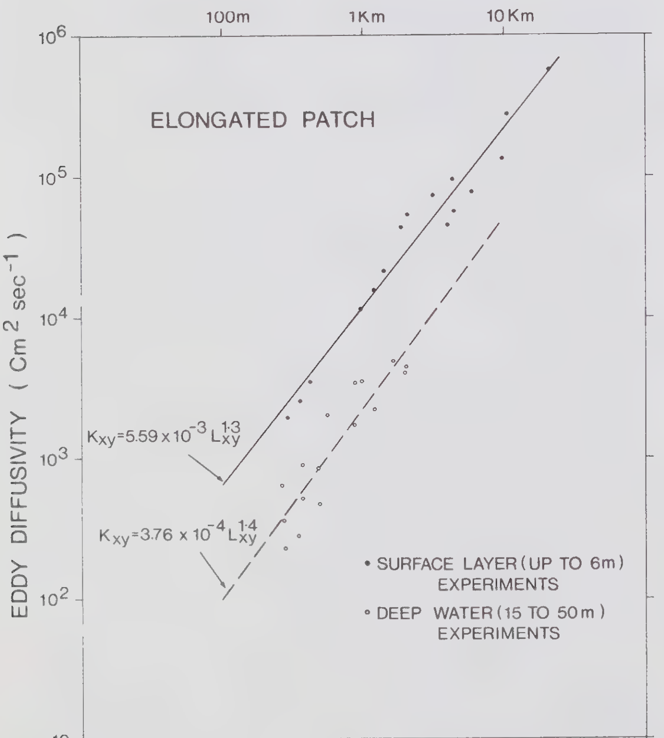


Figure 17. Apparent eddy diffusivity as a function of length scale based on 1972 field experiments.

from a technique permitting the accurate measurement of the current " fine structure".

Air — Lake Interaction

The main effort of the program consisted of the planning and execution of a complex series of experiments in Lake Ontario near the mouth of the Niagara River. The experimental facility (Fig. 18) consisted of three 80-foot bottom-mounted towers in 40 feet of water, on which were mounted meteorological instruments. Underwater power and signal cables ran from the towers to a barge anchored nearby. The barge was equipped with diesel generators for electrical power, shelters for recording instruments, and rough living accommodation for the investigators. The installation and maintenance of this facility was a challenging task in itself and could not have been achieved without the large and sustained efforts of the Scientific Division, Technical Operations Subdivision, and Marine Sciences Directorate at the Centre.

The primary objective of the experiments was the measurement of the exchange of momentum, heat, and moisture between the air and the water over a wide range of natural conditions. Particular emphasis was placed on the effects of atmospheric stability and wind speed immediately above the water surface upon the direction and rate of these transfers. Conditions in Lake Ontario vary from strongly stable in the spring (warm air, cold water) to

Figure 18. The Niagara micrometeorological facility. Sonic and hot-wire anemometers and wave gauges are mounted in tower at left; tower at right is the profile tower. Recording equipment was housed in the barge, anchored several hundred feet away.

strongly unstable in the fall (cold air, warm water) and the possibility of obtaining such a wide range of conditions at a single site alone makes the data particularly valuable. The application of these measurements, in addition to possible new insights into the physics of air-water transfers, is towards an improved ability to estimate the net exchange of momentum, moisture and energy (mechanical and thermal) between air and water from measurement of a few well-selected and simply-obtained parameters such as mean wind speed and air-water temperature differences at fixed reference heights.

With this latter aim in view, measurements have been made with a variety of instruments ranging from rapid response probes, from which the turbulent fluxes may be measured directly, to the standard moored meteorological system which measures wind speed, air temperature and humidity at a fixed (4 m) height above water level.

Data were gathered during four periods of about two weeks each, in May, June, August and October. Three of the periods were marked by occurrences of strong winds. At times this caused delays because of the difficulty in landing people safely on the barge from small boats. Nevertheless a large and valuable collection of data was made.

The barge and tower facility served as a platform for other investigators from the Atmospheric Environment Service of Canada, the Atlantic Oceanographic Laboratory at Dartmouth, N.S., and the Pennsylvania State University. The measurements will be used also for comparison with similar data gathered during the overflights of research aircraft.

Heat Content and Thermal Structure of Lake Ontario

One of the core projects of the International Field Year is a detailed thermal energy balance of Lake Ontario. This balance will allow estimates to be made of lakewide transfers of latent (evaporation) and sensible heat across the water surface. These estimates in turn will serve as bases for the comparisons of other, independent, measurements of these transfers and so help to refine present methods of estimating air water transfers from standard meteorological observations.

A key term in the energy balance equation is the time rate of change of quantity of the heat stored in the lake. For Lake Ontario this term has a mean daily value comparable in size to the other heat fluxes. In principle, the quantity of heat stored in the lake may be computed from synoptic temperature profile data by constructing an approximate integral of the temperature field over the lake volume. Simple estimates show that useful accuracy can be obtained with a 93-station sampling grid and using two vessels equipped with standard EBT's to obtain a temperature profile at each grid point within a 50-hour period. Starting April 4, 32 such surveys were carried out during 1972 with both Canadian and U.S. vessels. The raw data in the form of graphs of temperature versus depth have been edited and processed at CCIW, and preliminary computations of the stored heat content at the midpoint of each survey have been made. From these calculations it appears that Lake Ontario took longer to warm up in 1972 than in other years but that the total stored heat (change from minimum to maximum) was not significantly different from past values. The program is being carried on through the early part of 1973.

A useful by-product of these surveys is the series of near-synoptic pictures of the lakewide thermal structure (Table 4) which may be readily assembled (cross-sections, surface distributions, etc.) from the temperature profile data. A series of preliminary reports has been issued describing this structure and attempting to relate it to meteorological events. The same data set have been used also to estimate available potential energy and its changes as they relate to mechanical energy transformations within the lake.

River outflow temperatures were collected at the mouths of the Credit, Humber, Ganaraska, Trent, and Moira Rivers along the north shore of Lake Ontario as part of a program to estimate the quantity of heat advected into the lake by its tributaries. Local observers were recruited to maintain thermographs and to take a daily surface temperature. The field measurements were made from early April through late November.

It was recommended by the IFYGL Energy Balance and Water Movements panels that long-time series data on the thermal structure be collected at some points in the lake. The Section, together with the Engineering Systems Section and the Technical Operations Section, undertook the design, procurement and emplacement of four fixed temperature profilers in Lake Ontario. The technical aspects of this program have been described in an En-

gineering Report (Harrison & Watson 1972). As is usual with prototype systems, there were some failures, but the gross data return is estimated to be about 60% and should prove to be a valuable contribution to the total collection.

The Section contributed to the Water Movements Program of the IFYGL via three temperature transect cruises conducted aboard C.S.S. LIMNOS. The purpose of the cruises was to detect long standing internal waves of the Poincaré type, thought to be a dominant feature in the offshore zone under stratified conditions. These waves can be detected by measuring the time and space changes of the thermal structure (notably the position of the main thermocline) along a transect of the lake. Two towed systems were deployed from LIMNOS, an undulating vehicle carrying a temperature and a pressure (depth) sensor (Bedford Batfish), and an array of thermistors mounted on a faired cable. The LIMNOS crossed the lake repeatedly on a line from Oshawa, Ontario, to Olcott, New York at a speed of 7 knots. Each experiment lasted 4 1/2 days and comprised roughly 22 crossings of the lake.

In all 3 cruises, evidence of basin-wide internal standing waves has been observed (Fig. 19), as well as much revealing data on the nature and possible sources of some of the short progressive internal waves.

Hydrodynamic Modelling

Extensive investigations were carried out with a three-dimensional model of Lake Ontario in order to take full advantage of the IFYGL data. Model verification using this data was started as soon as the observations became available. The occurrence of tropical storm Agnes in the second half of June constituted a singular event well suited to this verification. A detailed analysis was made of the observed wind stress and atmospheric pressure fields in order to provide suitable input to the model. In general, the water levels and currents computed by the model are in good agreement with the field observations.

In order to illustrate the applications of numerical models, a film entitled "Computer Simulation of Water Movements in Lake Ontario" was made at the National Centre for Atmospheric Research in Boulder, Colorado. The film was made using the computer facilities in Boulder and runs about 12 minutes. A copy of the film may be borrowed from the CCIW library.

A more specialized model has been developed (Hamblin, 1972) with the purpose of studying the causes and characteristics of lake seiches. A general numerical method permits an examination of the effects of the earth's rotation, realistic bathymetry, and shoreline configuration on the frequencies, free-surface topography and current distribution of lake seiches. The method was first applied to the five lowest mode gravitational seiches and the lowest rotational seiche in Lake Ontario. Work has continued on the mechanisms of generation of surface and internal seiches by atmospheric and tidal forces, and an analysis of observed water level fluctuations in Lake Ontario is in

Table 4. Average temperature (0°C) of horizontal layers in Lake Ontario computed from 1972 Heat Content Survey data.

LAYER	Cruise Dates													
	6/4	11/4	18/4	25/4	2/5	9/5	16/5	25/5	1/6	6/6	14/6	21/6	28/6	6/7
0 → 10m	1.37	1.47	1.90	2.16	2.71	3.14	3.57	5.61	6.12	7.39	7.25	9.83	10.47	13.16
10 → 25	1.38	1.48	1.77	2.02	2.46	2.78	3.02	3.64	4.26	4.38	5.37	5.75	6.78	7.15
25 → 50	1.46	1.52	1.74	1.94	2.31	2.49	2.75	3.22	3.54	3.75	4.00	4.09	4.60	4.68
50 → 100	1.57	1.57	1.77	1.94	2.19	2.38	2.44	2.99	3.21	3.55	3.73	3.85	3.99	4.05
100 → 150	1.98	1.99	1.89	2.04	2.31	2.36	2.49	2.90	3.13	3.37	3.37	3.64	3.85	3.91
150 +	2.01	2.38	2.36	2.32	2.34	2.40	2.50	3.10	3.21	3.25			3.89	3.91

LAYER	Cruise Dates												
	18/7	2/8	29/8	5/9	13/9	19/9	26/9	11/10	17/10	26/10	7/11	22/11	28/11
0 → 10m	17.47	18.61	19.01	19.16	18.86	17.56	16.69	12.19	9.39	9.41	8.75	6.94	6.00
10 → 25	8.08	10.37	13.09	13.57	13.60	14.65	13.31	11.70	9.24	9.04	8.52	6.91	5.95
25 → 50	4.68	4.76	5.52	5.61	5.69	6.15	5.69	8.38	8.25	7.83	7.53	6.69	5.95
50 → 100	4.04	4.02	4.10	4.12	4.10	4.12	4.16	4.24	4.97	4.71	4.90	5.41	5.68
100 → 150		3.88	3.90	3.92	3.92	3.93	3.99	3.88	3.91	3.91	3.96	4.09	4.64
150 +		3.85	3.89	3.88	3.86	3.85	3.96	3.82	3.76	3.80	3.84	4.00	4.02

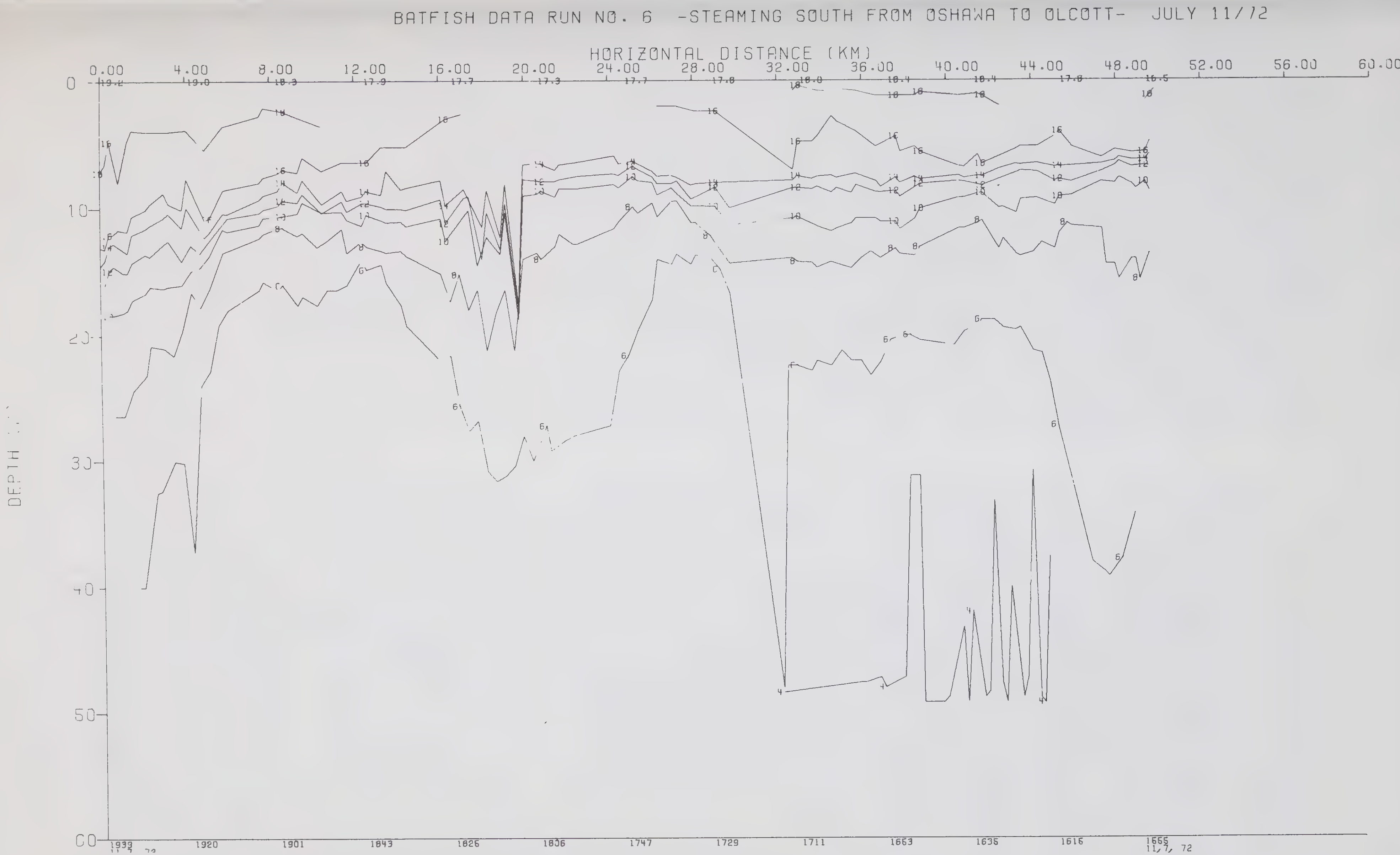


Figure 19. A temperature cross-section of Lake Ontario assembled from measurements made with the Batfish system during the transect experiment of 10-14 July 1970. The origin of the horizontal scale is Olcott, New York.

progress with a view to using it as a basis for comparison between predicted and observed behaviour.

Project Oshawash

From 1969 through to 1972 a large amount of data has been collected in the vicinity of Oshawa, Ontario, by the University of Waterloo (Coastal Chain Project) supported under contract from CCIW, and by CCIW scientists themselves. The tacit aim of these experiments has been to study the nearshore regime at a site which is relatively free from large topographical variations and local influences such as major rivers. Due to Field Year preparations and other commitments, the detailed analyses of these records had been previously postponed; this year it has been possible to make a start.

The current meter data of 1970 from the nearshore area off Oshawa has been edited and transformed into a more accessible form. Some analyses have been completed and others are under way. The total kinetic energy o horizontal motion (mean speeds plus variance) increase over the field season from May to late October. There is tendency for the energy to decrease with distance offshor in the spring and summer records but such a tendency wa not observed in the fall records, although it may well b that the measurements did not extend far offshore (Fig 20). Most of the total energy occurred at periods in exces of three days, but significant quantities were found at o near the local inertial period (17.5 h). It is interesting t note that while the total and the long-period energy de crease with distance offshore, the energy in the inertial pe riod range tends to increase offshore. This last observatio would be consistent with the reflection of long interna waves from a sloping shoreline.

Instrumentation Development

The Section, in collaboration with the Centre's en gineers, is active in developing new instrumentation ap

TOTAL ENERGY ($\bar{u}^2 + \bar{v}^2 + \overline{u'^2} + \overline{v'^2}$) OF ALL RECORDS OFF OSHAWA – 1970

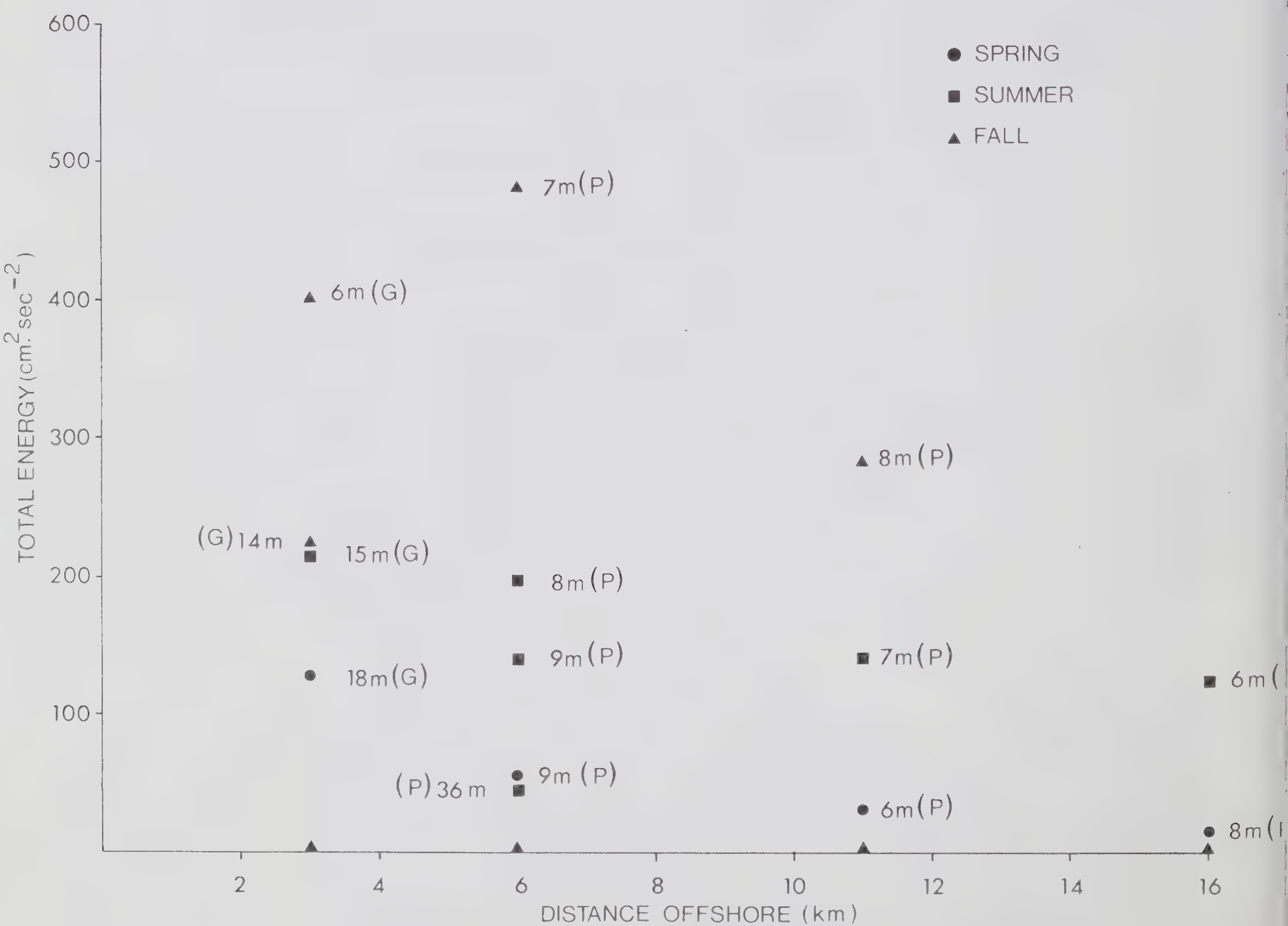


Figure 20. Total horizontal kinetic energy in a frequency band from 0 to 1 cycle per hour measured with current meters in the Oshawa region of Lake Ontario in 1970 and plotted as a function of distance offshore.

ropriate to its field activities. The towed thermal profiling ystem, Batfish and towed array, have been carried forward, ith the former system now considered to be operational ot only for temperature profiling but also as a general latform for *in situ* instrumentation. Development of the xed temperature profiling system continued through 972. The Section is investigating the techniques of *in situ* uorometry of obvious advantage for diffusion studies. The eeds of the micro-meteorology program have promted iany developments, notably in the remote positioning of ower mounted sensors. Trials were made on an electro-iagnetic current meter designed to measure the orbital elocities of surface wave motion.

ontract and Cooperative Studies

Professor G.T. Csanady of Waterloo University carried ut an experimental program, code-named "Coastal Jet roject", to obtain detailed information on the structure of earshore currents. Two coastal chains (15 km long with 12 tations) normal to the shoreline were established off)shawa and Presqu'ile, Lake Ontario. Three periods of four eeks intensive measurements of currents and temperature ere taken (using the flag station technique) at time and pace intervals. A detailed report upon these contract ivestigations will be available in 1973.

CCIW also supported work by the Great Lakes Insti-ute under the direction of Dr. G.K. Rodgers. Water emperature measurements were made at the mouth of the lumber River from April through November 1972 as a ontribution to the Energy Balance Program of the IFYGL. wo recording thermographs were maintained on a ottom-mounted tower off Toronto. A number of detailed emperature surveys were conducted on the northwest iore of Lake Ontario from the C.G.S. PORTE DAUPHINE i July and August in order to document episodes of lake pwelling in response to westerly winds. A report is orthcoming on this last project.

The contributions of Professor Kullenberg and Mr. Vesterberg to the IFYGL diffusion program were also upported under CCIW contract. A detailed report of their ork will be available shortly.

The Niagara barge facilities were made available during uly to a group headed by Professor G. Harris from the iology Department of McMaster University. In addition to iological studies on the diurnal fluctuations of primary roduction, this group investigated the occurrence and ertical circulations associated with Langmuir vortices. Results of this work were reported to CCIW in a seminar iven by Professor Harris in November.

An additional cooperative program with the De-artment of Civil Engineering of the University of Waterloo as made possible the extension of activities related to earshore diffusion studies. It is expected that Mr. E.L. kiba will contribute significantly to the Section in his apacity as a doctoral student.

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BIOGEOCHEMICAL LIMNOLOGY SUBDIVISION

The subdivision carries out studies on the impact of introductions of natural and man-made substances into lake systems, with special emphasis on their limnological behaviour, complex interactions and relationship to lake water quality. This group of specialists within the broad field of chemistry provides the fundamental understanding of chemical processes in lake waters as a basis for the work of others engaged in water quality management.

The projects carried out in the Geochemistry Section range from measurements of the partial pressure of carbon dioxide in air over Lake Ontario, and a survey of the stable isotope composition of sulfate sulfur in waters of four of the Great Lakes, to laboratory studies on the thermo-dynamics of some synthetic phosphates of lead and zinc and their associated dissolved species, and several projects on the properties of lake sediments, including sedimenta-tion rates, organic carbon, nitrogen, phosphorus and mercury, amino acids and amino sugars, humic and fulvic acids, chlorophylls and chlorophyll derivatives. In addition, studies were made on various forms of phosphorus, and several heavy metals (Zn, Cu, Ni, Cd, Pb and Mn) in cores from Okanagan Lake as well as some of the Great Lakes.

The Environmental Impacts and Developmental Chemistry Section includes a group engaged in assessing the environmental impact of new substances, generally working in close co-operation with colleagues in the Fisheries Research Board Detachment. Studies in this area include research on a bacterial mutant capable of rapidly degrading NTA, and on the ability of natural populations of bacteria to degrade certain PCB's; a monitoring program for NTA in Hamilton Harbour and western Lake Ontario; and development of a new and convenient analytical method for EDTA and NTA.

Other laboratory projects of the Section include oil/water studies; the physical chemistry for multi-component brines; and study of the complexing properties of humic materials with mercury and copper.

Field-and-laboratory projects include a study of carbon and phosphorus dynamics in lake water; study of the chelation capacity and chemical form of several heavy metals in a number of lakes near Sudbury, Ontario; a study

of the occurrence of methyl mercury; research on methods for concentrating, extracting and identifying dissolved organic compounds.

Carbon Dioxide in Air over Lake Ontario

This study was off to a late start with the arrival in August of a UNOR 2 infrared carbon dioxide analyzer. With this instrument carbon dioxide over the lake can be measured with a precision of about 2 ppm. The equipment was set up on the MV MARTIN KARLSEN for two of the IFYGL OOPS cruises, in September and October. The mean value in September in the middle of Lake Ontario, averaged over twenty four hours, was 322 ppm. A diurnal cycle, with low values in the afternoon, was observed. In October, after there had been several frosts, no cycle was observed, and the mean value was higher, 330 ppm. The carbon dioxide content of air fluctuates considerably, especially in the vicinity of cities. Extremes of 315 to 360 ppm have been observed.

Stable Isotopes of Sulfate Sulfur in Great Lakes Waters

A general survey of the isotopic abundance of sulfur in (dissolved) sulfates in Lakes Michigan, Huron, Erie and Ontario has been made. (Sample analyses were done by contractual arrangement with J. Monster of the Chemistry Department, McMaster University.) The results obtained so far indicate that whereas the isotopic abundance in Lake Erie shows both regional and temporal variations, Lakes Michigan, Huron and Ontario remain homogeneous with respect to their sulfur isotopic compositions. Average δS^{34} values for the lakes are: Lake Michigan $+ 4.6^0/_{00}$, Lake Huron $+ 6.3^0/_{00}$, Lake Erie $+5.5^0/_{00}$ (range $+ 4.9 - +6.6^0/_{00}$) and Lake Ontario $+ 5.9^0/_{00}$. These results may be compared with the sulfate concentrations, which generally show a progressive increase eastward from Lake Michigan to Lake Ontario (mean sulfate levels: L. Michigan 19.5 ppm, L. Huron 16.2 ppm, L. Erie 21.4 ppm and L. Ontario 27.6 ppm).

A VG Micromass 602C mass spectrometer capable of determining stable isotope ratios of carbon, nitrogen, oxygen and sulfur with a precision of $0.2^0/_{00}$ or better is on order and a more intensive study on the isotopic composition of the Great Lakes is planned for next year.

Lead and Zinc Phosphates

Because of the possible geochemical and ecological importance of lead, a study was made of the solubilities of a number of lead phosphates and hydroxides, and the associated equilibria in solution, in order to improve our understanding of the behavior of these species in the environment. It was found that lead phosphates, particularly the pyromorphites, are very stable, and are the lead minerals most likely to be precipitated in aerobic soils and lake sediments.

Solubility product constants and free energies of formation were determined for the solid phases.

Phase	pK_{sp}	ΔG_f^o (K cal mol^{-1})
$PbHPO_4$	11.4	-281.8
$Pb_3(PO_4)_2$	44.5	-565.0
$Pb_4O(PO_4)_2$	–	-617.3
$Pb(OH)_2$	20.4	-108.8
$Pb_5(PO_4)_3OH$	76.8	-902.0
$Pb_5(PO_4)_3Cl$	84.4	-905.2
$Pb_5(PO_4)_3F$	71.6	-942.0
$Zn_3(PO_4)_2 \cdot 4H_2O$	35.3	-867.3

Association constants for some ion pairs were determined:

Ion pair	log K_a
$PbH_2PO_4^+$	1.5
$PbHPO_4^0$	3.1

The data for the zinc phosphate indicate that it is too soluble to be likely to form in the lake environment.

Geochemical Inputs to Great Lakes Sediments

Sedimentation rates, organic carbon, nitrogen, phosphorus and mercury have been measured at close intervals in 14 cores from Lakes Ontario, Erie and Huron. Sedimentation rates range from a low of 0.6 mm of sediment per year in northern Lake Huron to a maximum of 1.6 cm per year in the deep eastern basin of Lake Erie. Preliminary estimates of the present day inputs to the three lakes are shown below.

Lake	Total sediment	Organic carbon	Total nitrogen	Total phosphorus	Mercury
	10^3 metric tons				
ONTARIO	4,360	256	29	7.6	.0127
ERIE	21,260	746	102	27.6	.0137
HURON	3,840	161	21	4.6	.012

The concentrations of organic carbon, nitrogen phosphorus, and mercury increase towards the surface of each core from a level representing deposition around 50 years BP. The increases are mainly due to increased loading to the sediments in recent years. The sediment enrichment factor (SEF) is defined as the ratio of the geochemical concentration in the top cm of sediment to the concentration representative of deposition 120 years BP. SEF values for the three lakes are shown below.

Lake	Organic carbon	Nitrogen	Phosphorus	Mercury
ONTARIO	3.10	3.10	2.34	52.0
ERIE	2.41	3.18	1.79	3.4
HURON	1.29	1.48	1.30	1.5

It can be seen that present day inputs to the Lake Huron sediments are little different to that of 120 years ago, whereas the Lakes Ontario and Erie sediments are receiving 1.8 to 52 times the natural load.

Sediment Organic Matter Studies

The distribution of amino acids and amino sugars in the surface sediments of Lake Ontario is similar to that found in Canadian soils and in ocean sediments. The changes in the amino acid content and reactivity towards proteolytic enzymes suggest that the pathway of degradation and transformation of amino acids in Lake Ontario is as follows: (1) lake cellular materials → (2) water soluble organic matter, containing soluble amino acids → (3) fulvic acids → (4) humic acids.

The molecular weight distribution of humic and fulvic acids from the surface sediments of Lakes Ontario and Erie ranges from less than 700 to over 200,000. The molecular weights of the humic and fulvic acids occur in three distinct ranges: (1) fractions with molecular weight over 200,000 (23–49%), (2) fractions from 5000 to 50,000 (31–58%) and (3) fractions less than 700 (0–22%).

Studies on chlorophyll were carried out as part of an M.Sc. Thesis at Queen's University, in conjunction with Dr. R. J. Daley and Prof. S. R. Brown. An integrated quantitative method was developed for the determination of chlorophylls and chlorophyll degradation products in freshwater phytoplankton and sediments. The pigments are extracted in acetone and separated by reverse phase thin-layer chromatography. Using three chromatographic systems, artefact-free separations of chlorophylls a, b and c, and eighteen of their derivatives are obtained. The procedures are rapid, simple and highly reproducible. Chlorophyll pigments are being currently determined in cores from Lakes Ontario, Erie and Huron.

Heavy Metals and Forms of Phosphorus in Lake Sediments

The fine-grained sediment of Lake Erie contain approximately one half of the total phosphorus as apatite, equivalent to 300-600 ppm P. The apatite appears to be entirely of detrital origin, as indicated by mineralogical studies, constancy with depth in sediment cores, and decreasing sediment content with increasing distance from shore. Much of the apatite is probably derived from eroding bluffs along the north shore. The bluffs contain 420-680 ppm P, over 95% of which is present as apatite. Detrital apatite contributes significantly to the total phosphorus sedimentation budget in Lake Erie.

The distribution of total phosphorus in the surficial sediments of lakes from the Okanagan valley, British Columbia, could be interpreted by considering the individual distributions of the three major forms of phosphorus in sediments. Apatite content declined with distance from stream and river mouths and distance from shore, indicating a predominantly detrital origin. Content of organic forms of phosphorus and inorganic forms of phosphorus other than apatite ("sorbed orthophosphate") increased with increasing water depth and/or distance from shore, and were closely related to contents of organic carbon and acid-extractable iron, respectively.

Diagenetic processes affecting phosphorus in sediments of the Great Lakes and the Okanagan lakes include mineralization of organic phosphorus and release of orthophosphate from combination with ferric iron (attendant on the decrease in Eh which results from the burial of material initially at the oxidized microzone by further additions of sediment). In addition, in two Okanagan lakes conversion of organic phosphorus to apatite appeared to be occurring. The frequently observed increase in total phosphorus towards the top of a sediment core is at least partly attributable to these processes rather than changes in loadings of phosphorus into the overlying water. However, in Lake Erie increases in organic phosphorus and sorbed orthophosphate content of recently deposited sediments apparently reflect chiefly the increase of phosphorus loadings into this lake in recent years.

Profiles of acid-extractable quantities of iron, manganese, copper, nickel, zinc and lead in sediment cores from the same lakes indicate a large enrichment of manganese in the oxidized microzone. The excess manganese is probably derived from underlying sediment by diffusion through the water column. Declining content of acid-extractable copper, nickel, lead and zinc in Lake Erie sediment cores appear to reflect increased loadings of these elements in recent years, as this feature was absent in the Okanagan sediment cores.

A contract with the Research and Productivity Council, Fredericton, New Brunswick was started to determine whether the forms of phosphate present in lake sediments can be identified by mineralogical methods on a routine basis. Two locations, from the western and eastern ends of the Central Basin of Lake Erie, were examined. Apatite was present in the sand-, silt- and clay-sized fractions. The origin, based on the morphology of the largest grains, was detrital. In addition, large amounts of fly-ash, a glassy material containing around 1% P and originating in the industrial region around Detroit, were found in the western station. Apart from this, the only other material of high phosphate content detected was two or three grains (out of several hundreds of grams of sample examined) of a material high in phosphorus and iron, possibly vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$).

Nutrient Dynamics

It seems that the most popular approach to lake pollution problems is to measure the *quantity* of some substances, e.g., phosphorus, chlorophyll, zooplankton, mercury etc. These measurements provide no information on the dynamics of lake processes or the turnover times of

the various components. To measure transport rates, experiments were conducted (in collaboration with University of Toronto, Department of Zoology and the Freshwater Institute, F.R.B., Winnipeg) on lake water using radioisotopes ^{32}P and ^{14}C. A model for phosphorus movement in the open water has been developed and the central role of a colloidal phosphorus form identified. Future work will be conducted in the Bay of Quinte. Ultimately the flux of the major nutrients (C, N and P) between the principal components of a lake ecosystem will be included in this model.

Complexing Capacity of Lakes

A method had been worked out to study the complexing capacity of lake water. It is measured by the amount of copper taken up by a water sample plus the complexed copper originally present in water. The method has been applied to the study of Sudbury lakes where the metals were abundant and yet the waters are still productive; obviously complexation is playing an important role. The complexing capacity of lake water has been found to relate closely to the amount of total dissolved organic matter in the water.

Work in progress includes measurement of the complexation capacity of typical lakes with an attempt to establish a complexation scale which when used with the trace metals data, gives us a better understanding of the trace element chemistry of the lake. In addition, work on the characterization of the complexing materials in lake water and the determination of the metal to ligand ratios which determine the relative availability of metals are also being carried out. Some typical complexation capacity values are listed as follows:

Sample	Complexing capacity µmole Cu equi/l.
Hamilton Harbour water	1 – 3
Niagara River (Niagara Falls)	0.6
Lake Ontario water	0.3 – 2
Sudbury lakes:	
Simon Lake	2.5
Johnnie Lake	0.4
Wanapitae Lake	1.4
Vermilion Lake	2.0
Loon Lake	2.4
Joe Lake	0.5
Makada Lake	1.3
Meatbird Lake	0.7 (No Cu uptake)
Whitefish Lake	0.29 (No Cu uptake)

In the course of complexation studies, the chemical state of some trace metals was also investigated. A method has been developed to measure the free and complexed metals in water (Zn, Pb, Cd, Cu) which has been applied to some 30 lakes in Sudbury area. In general, for lakes of normal pH (7-8) only Zn has been found to exist in free form whereas Mn, Cd and Cu are predominantly in complexed forms. Free Pb, Cd and Cu are most often observed in lakes of pH 5 or less. Under this low pH condition, the organic ligands are protonated and the complexation reactions are probably very much hindered. Metals like Cu which have a strong tendancy to form complexes can only exist in free form in water of low pH and low organic matter. From the survey of about 30 lakes in Sudbury area, only a very few lakes contained free copper. These are for example, Joe Lake pH 5, free copper 0.32 µmole/litre, complexed copper 0.34 µm/litre, Johnnie Lake pH 4.4, free copper 0.09 µm/litre, complexed copper 0.38 µmole/litre.

Organic Mercury Compounds in Lake Water

A very sensitive gas chromatographic technique has been developed to determine organo mercury compounds in lake water. The detection limits are extremely low: methyl mercury (0.02 ng/l), ethyl mercury (0.2 ng/l) and phenyl mercury (20 ng/l).

The technique has been applied to samples from St. Clair Lake and River, Saskatchewan River, Pinchy Lake, B.C., and Clay Lake, Kenora where very high mercury in fish has been reported. Methyl mercury was found only in the following samples:

St. Clair	0.6 ng/l
Clay Lake, Kenora	0.5 ng/l (Central lake)
	1 ng/l (near shore)
Pinchy Lake, B.C.	1.7 ng/l

Complexing Reactions of Humic Compounds

An equilibrium study of the Hg(II)-fulvic acid system using a solid state iodide electrode and a glass electrode indicates that the Hg (II)-fulvic acid complexes are in the order of 100 times more stable than those of Cu (II)-fulvic acid. This study also shows that fulvic acid is a very strong natural chelating agent. The Cu-NTA complexes are only about 1000 times more stable than those of Cu-fulvic acid.

Multicomponent Brines

Solubilities and activity coefficients in aqueous systems containing three salts are now being measured in the temperature range 0-25°C. The ultimate aim is to collect such data for the aqueous system containing the following ions: Na^+, Mg^{++}, K^+, Ca^{++}, Cl^-, $SO_4^=$, and HCO_3^-, as this system is representative of many of the world's natural waters.

Statistical Assessment of Monitor Cruise Data

A statistical examination of chemical monitor cruise data was undertaken. The average standard deviations from 22 1971-72 cruises (6 for particulate nitrogen and particulate organic carbon) were:

dissolved oxygen	.19	mgm O_2/l
pH	.04	log units
turbidity	.6	J.T.U.
specific electrical conductance	4.	µmho-cm^{-1}
soluble ammonia, filtered	.003	mg/l N
total nitrate, filtered	.012	mg/l N
total nitrogen, filtered	.021	mg/l N
particulate nitrogen	.010	mg/l N
particulate organic carbon	.062	mg/l C
soluble reactive phosphate, filtered	.0007	mg/l P
total phosphate, filtered	.0010	mg/l P
total phosphate, unfiltered	.0015	mg/l P
reactive silica	.070	mg/l SiO_2
chlorine, filtered	.2	mg/l Cl
total alkalinity, filtered	.7	mg/l as $CaCO_3$

Also, it was shown that there is no statistically significant difference for these parameters between the bottle and pump sampling methods employed at the Centre.

Organic Compounds in Lake Water

A Finnigan 1015 gas chromatograph-mass spectrometer with a systems industries 150 data system was acquired during the year. After some start-up difficulties, an identification level of 25 ng for methyl stearate injected on column was achieved. The instrument is being used to examine and identify organic compounds in water samples obtained by chloroform extraction and freeze concentration techniques. A telephone linked, computerized mass spectra library system (N.I.H., Bethesda, Md., U.S.A) of some 9,000 spectra is being investigated as a means of identification of the spectra obtained from environmental samples. Tentative identification of phthalate and fatty acid esters in Lake Erie waters has been accomplished.

The buffered hydrolysis of phytic acid (inositol hexaphosphate) to give orthophosphate has been undertaken. Rates of phosphate formation at pH 4.7 have been obtained and further work is underway at pH values up to 9.

Chlorinated biphenyl isomers have been tested for biodegradability and the chemical nature of their metabolites investigated. The 2- and 4- monochlorobiphenyls were degraded to give a variety of lower molecular weight metabolites most of which do not appear to contain chlorine.

A spectrophotometric method for the differentiation and determination of EDTA and NTA has been developed. Individual detection limits of 10 ppb for both compounds were achieved. An analytical method for the direct determination of residual methanol (down to 0.5 ppm) in waste waters has also been developed for sewage denitrification processes.

During July, 1972, the monthly sampling of seven stations in western Lake Ontario and of seven stations in Hamilton Harbour was resumed. The samples are taken by staff of the Technical Operations Section from the M.V. Lac Erie, and are analysed by staff of the Water Quality Branch. Some cross-confirmation of analytical results is done by the subdivision. A tendency for somewhat higher values observed during the severe winter weather of 1971-72 has not yet been observed this year.

Bacterial Degradation Studies

A bacterial mutant was found to be capable of using only NTA as a carbon and energy source for growth at concentrations as high as 2.5 per cent without acclimatization and at a wide range of temperatures, pH, ionic concentrations in both lake waters and sewage. It was able to degrade NTA from an initial concentration of 290,000 µg/l of NTA to less than 50 µg/l in 45 minutes, representing a rate of 486 µg NTA degraded per hour per mg dry weight of cells. The maximal temperature for the degradation was 50°C. The ability of the mutant to metabolize NTA resided mainly in the cell membrane fraction.

Bacteria isolated from Lake Ontario sediments were capable of degrading lower molecular weight components of the PCB's Aroclor 1221 and 1242. With purified isomers, bacteria were found to degrade 2-monochlorobiphenyl at a faster rate than 4-monochlorobiphenyl. These and other results suggest that not only the percent of chlorination but also the position of chlorine in the benzene ring are important in the bacterial degradation.

Oil-Water Studies

Laboratory studies have been completed on the formation of water-in-oil emulsions. The data await field evaluation during the 1973 season.

A survey of benzene extractable materials in Burlington Bay indicate a fairly uniform distribution in the water column at concentrations of about .4 ppm. The distribution of these materials in the sediment increases with depth to a maximum value of about one percent of dried sediment.

A technique was developed for the evaluation of oil herding agents in the laboratory. Tests on C_{16} and C_{18} alcohols and a commercial herding agent indicated that these materials are ineffective on aged oil slicks.

In co-operation with EPS personnel at the Centre a draft was prepared for the federal guidelines for oil spill dispersants.

MICROBIOLOGY SUBDIVISION

The Microbiology Subdivision moved into its new quarters in the Administration and Laboratory Building in March, 1972. Immediately after the move, the Microbiology Unit was separated into two units, one which was

oriented towards Water Management Service-Inland Waters Directorate programs and the other towards Environmental Protection Service programs. The two units continued to share the same facilities and equipment and often supported each other's projects through technical support and internal discussions. With the move to new quarters, the Microbiology Subdivision also undertook the tasks of (a) providing a media, chemical and glassware service to all Microbiology Units and (b) providing a glassware wash-up and sterilization service to the Centre.

The Microbiology Subdivision through various units became involved in a large number of very diverse studies. Some of these studies involved field work such as (a) an International Joint Commission study of the Rainy River, (b) a bacteriological study of the Ontario and Minnesota Pulp and Paper Company lagoon in Fort Frances, Ontario, (c) a bacteriological study of the St. Lawrence River from Kingston to Cornwall, Ontario, (d) a bacteriological study of Indian Reserve drinking water supply and (e) a microbiological research program on the Grand River and Burlington Bay. Other studies involved the provision of microbiological support to a variety of CCIW projects of which the following are representative: (a) lake organic particle studies, (b) Iron-manganese study in Lake Erie sediments, (c) sewage treatment nitrification study, (d) studies on the efficiency of the Attisholz sewage treatment system and (e) an acid mine waste study.

Microbiology Subdivision staff also initiated research studies in the following areas, nitrilotriacetic (NTA) degradation, hydrocarbon (oil) degradation, parameter development and sampling frequency for assessment of microbiological water quality and nutritional adaptions of sediment bacteria.

Other areas of involvement were the review of over thirty grant applications, contract proposals and papers, the testing of water and sewage samples from CCIW vessels, the chairing of an international meeting to draft a report to the IJC on the virus incidence and their role in the Great Lakes, the presentation of ten papers at various conferences and the serological identification of Klebsiella isolated from the Rainy River.

Parameter Development and Sampling Frequency Studies

Several reports were prepared on Design Guidelines for a Bacteriological Water Quality Network and Design Guidelines for a Bacteriological Sediment Quality Network, for inclusion in Guidelines for the Planning and Operation of Water Quality Network and the Interpretation of Data and the initiation of the following research projects.

In October a year-long joint project was initiated with the Water Quality Branch and Bacteriological Laboratories, EPS, Ottawa. Weekly samples were collected from the Grand River, Lake Ontario and the Ottawa River, and tested for total carbohydrates, ammonia-N, sulfate, fecal sterols, D.O., pH, temperature, rainfall, river flows, coliform MF, fecal coliform MF, fecal streptococci MF, direct count by fluorescent microscopy, 20°C spread plate count, Pseudomonas aeruginosa MPN, ammonifying bacteria, organic sulfur reducing bacteria, Salmonella incidence in water and mud, and Acinetobacter densities (Fig. 21). Superimposed on the weekly sampling program are eight weeks of daily sampling plus a.m.—p.m. sampling at one sampling site.

Figure 21. Illustrating the multitude of inoculations required during the testing of samples for various microbial physiological groups.

Project goals are the establishment of parameters most suitable for microbiological water quality assessment, seasonal effect on bacterial and chemical parameters, and optimal sampling frequency and minimum number of samples required for establishing the water quality of a specific water body.

One of the problems in water microbiological studies is the necessity to process water samples as soon as possibl

fter collection because of die-off an multiplication roblems. This problem is very important especially if acteriological studies are to be carried out in support of he Canada Water Quality Network. Therefore in conunction with the above project a year-long study was nitiated to study the effect of storing water samples up to 48 hours in ice, on microbiological and chemical parameters ised in the above study.

Water sample collection sites chosen represent waters containing high nutrient and high bacterial populations and ow nutrient and relatively low bacterial populations.

Detergent Degradation Studies

Because of the limited knowledge available on the mechanism of microbiological degradation of nitrilotriacetic acid (NTA), pure culture studies were initiated to more adequately delineate the basic mechanism involved. In tudies using NTA as a sole carbon and energy source for known pure cultures, little or no degradation occurred. Bacteria from sewage were then mutagenized by UV rradiation and selected with penicillin. By this technique a novel bacterial mutant with a high affinity for NTA was solated (Fig. 22). Each warburg flask contained 50μ moles of phosphate buffer (pH 7.0), 3.9 mg (dry wt) of sewage, (2) 6μ moles of NTA, (3) 6μ moles of citrate, (4) 1 ml of filter sterilized sewage. Total volume was 3 ml at 25°C. Additional 3μ moles of NTA were added after 180 minutes as indicated in the figure. The mutant could use high concentrations of NTA (up to 2.5%) as sole carbon, nitrogen and energy source without acclimatization at a

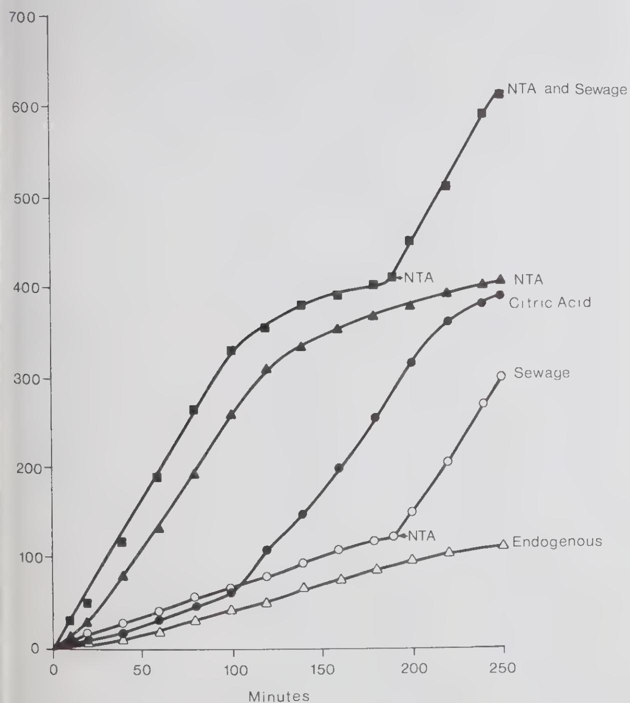


Figure 22. Comparison of sewage, NTA and citric acid oxidation by NTA degrading bacterial mutant.

wide range of temperatures and pH, with the probable intermediate products being glycine and acetic acid. This organism, under ideal conditions, could degrade 323 ppm NTA to much less than 10 ppm after 1 hours incubation at 25°C, representing over 96% degradation. In cyanide and azide addition studies, it was found that the energy-generating system and consequently the NTA accumulation was suppressed. The ability of bacteria to concentrate NTA suggests that the mutant could utilize very low NTA levels in receiving waters.

The results of these studies with the bacterial mutant indicate that the mutant could be used to seed sewage to remove excess NTA and that its enzymes could be incorporated directly into a detergent for "in-tub" degradation. Because of the above possibilities an application was made to the Canadian Patent office for patenting this mutant.

Hydrocarbon Degradation Studies

Success with the isolation and cultivation of a potent NTA–degrading bacteria that could be used as a seed in sewage treatment processes rekindled our interest in the role and importance of bacteria in natural and controlled degradation processes. A study was initiated of microbial oil degradation with the goal of trying to determine the feasibility of using seeding techniques to aid in oil spill clean up operations.

A simplified method was developed for rapidly screening and isolating potent oil-degrading bacteria. This technique led to the isolation of several bacterial strains that rapidly degraded kerosene, crude oil, bunker 6C and commercial oil dispersants (Fig. 23). During laboratory studies it was found that these bacteria could degrade hydrocarbon and oil-dispersants simultaneously. These studies indicated that the oil dispersants did not affect the degradation of oil by our culture, in fact they stimulated the rapid biodegradation of kerosene (Fig. 24). In kinetic studies, crude oil degrading bacterial culture CCIWCM01 was found to degrade crude oil rapidly and efficiently without the use of emulsifying agents and the rate of oil degradation was a function of oil concentration in the test medium.

In a comparison study between culture CCIWCM01 and a commercially available mixed culture, our bacteria CCIWCM01 was found to be much superior. Steps are now being taken to purify and classify these oil degrading bacteria in preparation for patent application.

Paper Mill and Rainy River Studies

Using a mobile laboratory, two studies of the Ontario and Minnesota Pulp and Paper Mill lagoon in Fort Frances and one of the Rainy River for the IJC were performed by CCIW Microbiology staff.

In the paper mill studies, a low incidence of E. coli and a relatively high incidence of *Enterobacter* strains were

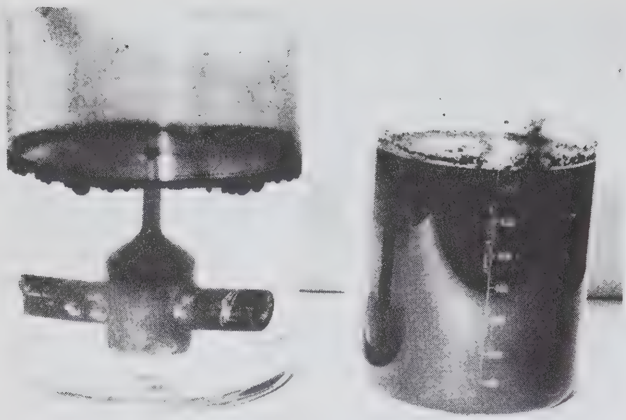


Figure 23. Isolation of Bunker 6C fuel oil-degrading bacteria using Bellco flask. Left: before growth. Right: two days after bacterial growth.

found in the kraft mill effluents, an indication that sanitary wastes were not present in these process wastewaters. The paper mill lagoon contributed a large input on non-fecal coliforms (predominantly *Enterobacter*) and nutrients to the Rainy River. These lagoon wastes contained high concentrations of sulfur substrates that promoted growth of sulfur oxidizing and sulfate reducing bacteria in the river below the mill outfalls. These bacterial parameters appear to be relatively sensitive indicators of industrial pollution. During this study it was found that a portion of fecal coliform populations were *Klebsiella* species, some of which

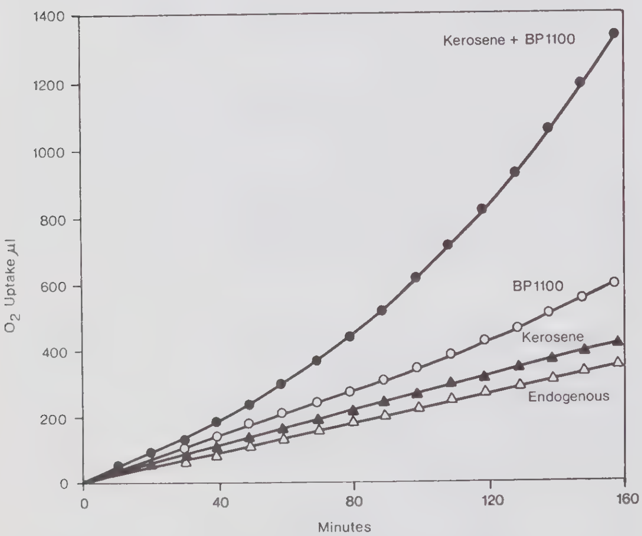


Figure 24. Effects of BP1100 on oxygen uptake by culture CCIWKO1. Each Warburg flask contained 6.2 mg (dry weight) of kerosene grown cells, 0.5 ml of 0.05 phosphate buffer (pH 7.0) and various substrates. All substrates were added at 0 hour after a preincubation of 15 min. The final volume of liquid in each flask was 3.0 ml and the temperature was 20C.

were *K pneumoniae* and gave a positive mouse patho genicity test.

Results of the IJC Rainy River study indicated that th Rainy River downstream from the Fort Frances International Falls area was grossly polluted with coliforn bacteria. The isolation of enteric pathogens from this are confirmed that these waters are a potential health hazard The major source of pollution was found to be the wast discharges from the two pulp and paper mills, occasiona inefficient operation of the two sewage treatment plant and runoff from storm sewers and the surrounding water shed.

TECHNICAL OPERATIONS SUBDIVISION

Major Ships

As in previous years, the C.S.S. LIMNOS and th chartered vessel M.V. MARTIN KARLSEN were used fo the scientific data collection and monitor cruises on th Great Lakes. The programs were augmented from time t time, with work done by the C.C.G.S. PORTE DAUPHINE through contract arrangements with the Great Lake Institute (GLI), University of Toronto.

The implementation this year of the IFYGL (Inte national Field Year for the Great Lakes) program on Lak Ontario placed a much increased load on both ship an personnel requirements, so that the field season whic normally terminates in early December continues throug the winter months to March, 1973.

The C.S.S. LIMNOS carried out a great variety c specialized cruises, thirty being completed by the end c 1972. These cruises can be broken down as follows:

5 Mooring Cruises,
3 Temperature Transect Cruises,
4 Bathymetric Surveys,
9 Heat Budget Surveys, and
6 Dye Diffusion Cruises.

There were also several smaller additional survey including Engineering Instrument trials and IFYGL inte comparison studies.

The M.V. MARTIN KARLSEN continued to be th work horse for CCIW and carried out all the monit cruises and "Organic Particle" (OOPS) cruises as follows:

7 OOPS Cruises — Lake Ontario
1 Monitor Cruise — Lake Ontario
5 Monitor Cruises — Lake Erie
3 Monitor Cruises — Lake Huron

The three extended monitor cruises into Lake Hurc included a spring and fall excursion into Lake Michigan ar Georgian Bay, representing the first time that a maj research vessel from CCIW has monitored these regior

Operational Table, 1972.

Ship	Started Operations	Completed Operations	No. Cruises	Miles Steamed	Total Active Days	Days On Survey	%
M.V. MARTIN KARLSEN	Mar. 13/72	Dec. 2/72	24	15,835	265	180	68
C.S.S. LIMNOS	Mar. 27/72	Dec. 20/72	30	17,480	270	169	63

(Complete schedules are given in Tables 5, 6, 7 and 8)

The remainder of the twenty-four cruises was divided etween the launching of DECCA and meteorological uoys, Decca chain calibrations, heat content surveys, plus wo intercomparison studies (Canada and U.S.) of ship-oard data acquisition systems and methods.

The C.C.G.S. PORTE DAUPHINE, in addition to arrying out work for the GLI, was under contract when ur major ships were unavailable for monitor work. These ruises, staffed by personnel from GLI and CCIW, were oordinated by Technical Operations and augmented the egular monitor program.

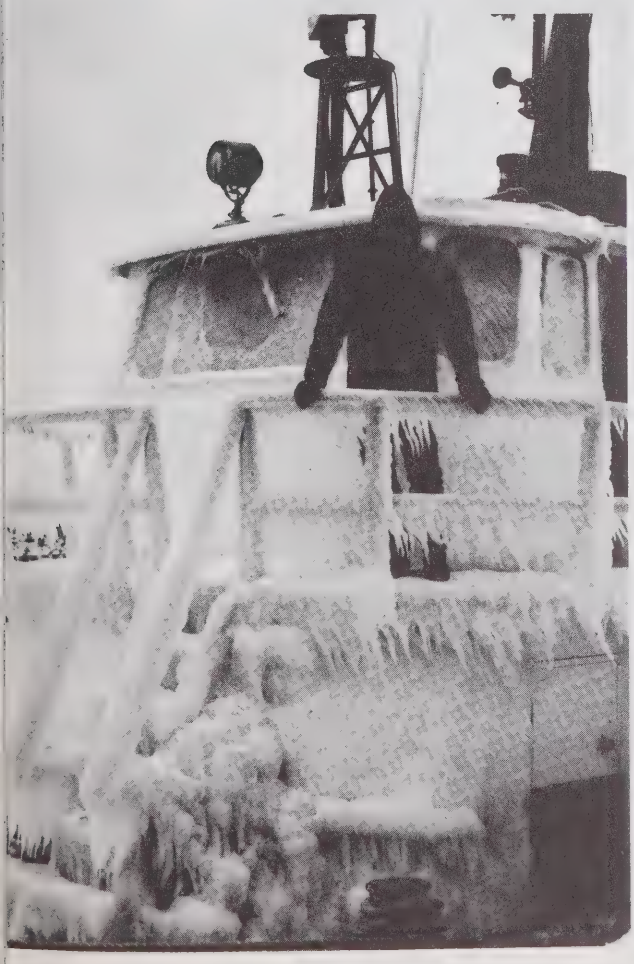


Figure 25. Winter operations MV LAC ERIE.

Minor Ships

Although not considered a major research vessel, the tug M.V. LAC ERIE, staffed by Technical Operations personnel, played a very important role during the field year, not only in carrying out many of the "special" cruises (Meteorological and FTP programs, NTA study, "MOSES" program, Pesticide study, Fe-Mn study), but also in supporting many of the "shore-based" field programs. Although not very large, she always managed to get the job done, often despite adverse weather conditions. (See Fig. 25).

The diving tender C.S.L. SHARK supported all diving programs in Lake Ontario in 1972, including the installation and maintenance of underwater sensors along the Canadian shore of the lake, installation and removal of the Niagara Towers, and operational support to the Oshawa Dye Diffusion project.

The chartered 100-foot barge HANDY BOY, containing a laboratory detachment from the Atmospheric Environment Service (AES), was moored for most of the season adjacent to the Niagara Towers.

An intermediate 80-foot vessel, the C.S.S. ADVENT, was delivered to CCIW during the latter part of the year and is expected to join the "fleet" in early 1973.

Small Craft

As in previous years, Technical Operations continued to coordinate, through the Marine Sciences Directorate, the assignment of smaller research craft to various subdivisions at CCIW, universities, and other outside agencies.

IFYGL

Much of the IFYGL program and liaison with the participating U.S. agencies were coordinated by Technical Operations. Staff were involved in the preparation of the IFYGL "Operational Procedures Manual", together with finalization of the IFYGL cruise plans and operational movement of ships.

Diving Section

During the 1972 field season, the Diving Section supported twenty programs totalling 184 diving days in Lakes Ontario, Erie, and Huron. Tasks performed ranged

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31	1	2	3	4	5
FEB	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	1	2	3	4
	5	6	7	8	9	10	11
MAR	12	13 Depart CCIW 1115 hrs	14 Lake Ontario	15 DECCA Buoys	16 Arrive CCIW 1000 hrs	17 CCIW	18 CCIW
	19 CCIW	20 CCIW	21 Depart CCIW 0930 hrs	22 Lake Ontario	23 Met. Buoys	24 Arrive CCIW 0840 hrs	25 CCIW
	26 CCIW	27 CCIW	28 CCIW	29 Depart CCIW 1405 Lake Ontario	30 Met. Buoys Arr. CCIW 1335	31 CCIW	1 CCIW
	2 CCIW	3 Depart CCIW 1023 hrs	4 Lake Ontario DECCA Chain	5 Arrive CCIW 1145 hrs	6 Depart CCIW 1900 hrs	7 Lake Ontario	8 DECCA Chain Calibration
APR	9 Arrive CCIW 1615 hrs	10 Depart CCIW 1425 hrs	11 Lake Ontario	12 Organic Particle	13 Study	14 Arrive CCIW 2310 hrs	15 CCIW
	16 CCIW	17 Depart CCIW 1110 hrs	18 Lake Ontario	19 Organic	20 Particle	21 Study	22 Arrive CCIW 0850 hrs
	23 CCIW	24 Depart CCIW 0950 hrs	25 Lake Erie	26 Monitor	27 Lake Erie	28 Arrive Sarnia 2250 hrs	29 Sarnia
	30 Sarnia	1 Depart Sarnia 1740 hrs	2 Lake Huron	3 a nd Georgian Bay	4 Monitor and	5 Moorings	6 Lake Huron
	7 and Georgian Bay	8 Monitor	9 Moorings	10 Lake Huron and	11 Georgian Bay	12 Arrive CCIW 0830 hrs	13 CCIW
MAY	14 CCIW	15 CCIW	16 CCIW	17 Depart CCIW 1215 hrs	18 Lake Ontario Equipment Trials	19 Arrive CCIW 1705 hrs	20 CCIW
	21 CCIW	22 CCIW	23 Depart CCIW 1110 hrs	24 Lake Ontario	25 Organic Particle	26 Study	27 Arrive CCIW 1230 hrs
	28 CCIW	29 Depart CCIW 1135 hrs	30 Lake Ontario	31 Organic	1 Particle	2 Study	3 Arrive CCIW 0730 hrs
	4 CCIW	5 Depart CCIW 0945 hrs	6 Lake Erie	7 Monitor	8 Lake Erie	9 Monitor	10 Lake Erie
JUNE	11 Arrive CCIW 1440 hrs	12 CCIW	13 CCIW	14 Re-fitting	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 Depart CCIW 1150 hrs	20 Lake Ontario	21 Organic Particle	22 Study	23 Arrive CCIW 1440 hrs	24 CCIW
	25 CCIW	26 Depart CCIW 1010 hrs	27 Lake Ontario	28 Intercomparison and	29 Organic Particle	30 Studies	1 Arrive CCIW 1245 hrs
	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW
JULY	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW
	16 CCIW	17 Depart CCIW 1040 hrs	18 Lake Ontario	19 Organic Particle	20 Study	21 Arrive CCIW 1515 hrs	22 CCIW
	23 CCIW	24 Depart CCIW 1040 hrs	25 Lake Ontario	26 Organic	27 Particle	28 Study	29 Arrive CCIW 0630 hrs
	30 CCIW	31 Depart CCIW 0940 hrs	1 Lake Erie	2 Monitor	3 Lake Erie	4 Monitor	5 Arrive Sarnia 2240 hrs
AUG	6 Sarnia	7 Sarnia	8 Depart Sarnia 1545 hrs	9 Lake Huron	10 Monitor	11 and	12 Moorings
	13 L a k e	14 H u r o n	15 M o n i t o r	16 and	17 Moorings	18 Arrive Sarnia 1645 hrs	19 In transit
	20 Arrive CCIW	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW
	27 CCIW	28 Depart CCIW 0830 hrs	29 Lake Ontario DECCA Chain	30 Arrive CCIW 0400 hrs	31 CCIW	1 CCIW	2 CCIW
	3 CCIW	4 CCIW	5 Depart CCIW 1113 hrs	6 Lake Ontario	7 Organic Particle	8 Study	9 Arrive CCIW 1455 hrs
SEP	10 CCIW	11 Depart CCIW 1035 hrs	12 Lake Ontario	13 Organic	14 Particle	15 Study	16 Arrive CCIW 0540 hrs
	17 CCIW	18 Depart CCIW 0000 hrs	19 Lake Ontario	20 Intercomparison	21 Study and	22 Monitor	23 Arrive CCIW 2040 hrs
	24 CCIW	25 CCIW	26 CCIW	27 Depart CCIW 0915 hrs	28 Lake Erie	29 Monitor	30 Lake Erie
	1 Monitor	2 Arrive CCIW 2350 hrs	3 Depart CCIW 1213 hrs	4 Lake Ontario	5 Heat Content Survey Eutrophication Study	6 Arrive CCIW 1630 hrs	7 CCIW
OCT	8 CCIW	9 CCIW	10 CCIW	11 Depart CCIW 1035 hrs	12 Lake Ontario	13 Moorings	14 Lake Ontario
	15 Moorings	16 Arrive CCIW 1655 hrs	17 Depart CCIW 1315 hrs	18 Lake Ontario	19 Organic Particle	20 Study	21 Arrive CCIW 1545 hrs
	22 CCIW	23 Depart CCIW 1135 hrs	24 Lake Ontario	25 Organic and	26 Particle	27 Study	28 Arrive CCIW 1020 hrs
	29 CCIW	30 Depart CCIW 1455 hrs	31 Lake Huron	1 Lake Michigan	2 Monitor	3 and	4 Moorings
NOV	5 Lake Huron and	6 Lake Michigan	7 Monitor	8 and	9 Moorings	10 Arrive Sarnia 0845 Depart Sarnia 0930	11 Lake Erie
	12 Monitor	13 Lake Erie	14 Monitor	15 Arrive CCIW 1340 hrs	16 CCIW	17 CCIW	18 CCIW
	19 CCIW	20 Depart CCIW 1105 hrs	21 Lake Ontario	22 Organic Particle	23 Study	24 Arrive CCIW 1050 hrs	25 CCIW
	26 CCIW	27 Depart CCIW 1225 hrs	28 Lake Ontario	29 Organic	30 Particle	1 Study	2 Arrive CCIW 0345 hrs
	3	4	5	6	7	8	9
DEC	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30

Table 5. Great Lakes studies, IFYGL, 1972. MV MARTIN KARLSEN.

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31	1	2	3	4	5
	6	7	8	9	10	11	12
FEB	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	1	2	3	4
	5	6	7	8	9	10	11
MAR	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27 Dep. CCIW 0846 Lake Ontario	28 Met. Buoys Arr. CCIW 1445	29 CCIW	30 CCIW	31 CCIW	1 CCIW
	2 CCIW	3 CCIW	4 Dep. CCIW 1154 hrs.	5 Lake Ontario	6 Heat Content Survey	7 Arr. CCIW 1005 hrs.	8 CCIW
	9 CCIW	10 Dep. CCIW 1215 hrs.	11 Lake Ontario	12 Heat Content Survey	13 Arr. CCIW 1035 hrs.	14 CCIW	15 CCIW
APR	16 CCIW	17 Dep. CCIW 1151 hrs.	18 Lake Ontario	19 Heat Content Survey	20 Arr. CCIW 1212 hrs.	21 CCIW	22 CCIW
	23 CCIW	24 Dep. CCIW 1150 hrs.	25 Lake Ont. Heat Content Survey	26 Arr. CCIW 2215 hrs.	27 CCIW	28 CCIW	29 CCIW
	30 CCIW	1 Dep. CCIW 1152 hrs.	2 Lake Ontario	3 Heat Content Survey	4 Arr. CCIW 0612 hrs.	5 CCIW	6 CCIW
	7 CCIW	8 Dep. CCIW 1153 hrs.	9 Lake Ontario	10 Heat Content Survey	11 Arr. CCIW 1145 hrs.	12 CCIW	13 CCIW
MAY	14 CCIW	15 Dep. CCIW 0920 hrs.	16 Lake Ontario	17 Moorings	18 Moorings	19 Arr. CCIW 1544 hrs.	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 Dep. CCIW 1019 hrs.	30 Lake Ont. Diffusion Study	31 Arr. CCIW 2050 hrs.	1 CCIW	2 CCIW	3 CCIW
	4 CCIW	5 Dep. CCIW 0853 hrs.	6 Lake Ontario	7 Energy Budget Study	8 Heat Content Survey	9 Arr. CCIW 1842 hrs.	10 CCIW
JUNE	11 CCIW	12 Dep. CCIW 0915 hrs.	13 Lake Ontario	14 Bathymetric	15 Survey	16 Bathymetric	17 Survey
	18 Bathymetric	19 Survey	20 Bathymetric	21 Survey	22 Arr. CCIW 2230 hrs.	23 CCIW	24 CCIW
	25 CCIW	26 Dep. CCIW 0851 hrs.	27 Lake Ontario	28 Inter- comparison	29 & Diffusion Study	30 Arr. CCIW 1511 hrs.	1 CCIW
	2 CCIW	3 CCIW	4 Dep. CCIW 1020 hrs.	5 Lake Ontario	6 Moorings	7 Moorings	8 Arr. CCIW 0236 hrs.
	9 CCIW	10 Dep. CCIW 1033 hrs.	11 Lake Ontario	12 Temperature	13 Transects	14 Arr. CCIW 1525 hrs.	15 CCIW
JULY	16 CCIW	17 Dep. CCIW 0915 hrs.	18 Lake Ontario	19 Diffusion Study	20 Arr. CCIW 2250 hrs.	21 CCIW	22 CCIW
	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW
	30 CCIW	31 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 Dep. CCIW 0930 hrs.	9 Lake Ontario	10 Temperature	11 Transects	12 Arr. CCIW 1615 hrs.
AUG	13 CCIW	14 Dep. CCIW 1150 hrs.	15 Lake Ontario	16 Diffusion Study	17 Diffusion Study	18 Diffusion Study	19 Arr. CCIW 1024 hrs.
	20 CCIW	21 Dep. CCIW 1020 hrs.	22 Lake Ontario	23 Moorings	24 Arr. CCIW 1610 hrs.	25 CCIW	26 CCIW
	27 CCIW	28 Dep. CCIW 0905 hrs.	29 Lake Ontario	30 Diffusion Study	31 Diffusion Study	1 Diffusion Study	2 Arr. CCIW 1402 hrs.
	3 CCIW	4 CCIW	5 Dep. CCIW 0915 hrs.	6 Lake Ontario	7 Diffusion Study	8 Diffusion Study	9 Arr. CCIW 0805 hrs.
SEPT	10 CCIW	11 Dep. CCIW 0915 hrs.	12 Lake Ontario	13 Bathymetric	14 Survey	15 Bathymetric	16 Survey
	17 Bathymetric	18 Survey	19 Bathymetric	20 Survey	21 Bathymetric Survey	22 Arr. CCIW 1345 hrs.	23 CCIW
	24 CCIW	25 Dep. CCIW 0958 hrs.	26 Lake Ontario	27 Diffusion Study	28 Diffusion Study	29 Diffusion Study	30 Arr. CCIW 1415 hrs.
	1 CCIW	2 Dep. CCIW 0940 hrs.	3 Lake Ontario	4 Temperature	5 Transects	6 Arr. CCIW 1515 hrs.	7 CCIW
	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
OCT	15 CCIW	16 Dep. CCIW 1000 hrs.	17 Lake Ontario	18 Diffusion	19 Study	20 Arr. CCIW 1430 hrs.	21 CCIW
	22 CCIW	23 Dep. CCIW 0900 hrs.	24 Lake Ontario	25 Bathymetric	26 Survey	27 Arr. CCIW 1600 hrs.	28 CCIW
	29 CCIW	30 Dep. CCIW 0900 hrs.	31 Lake Ontario	1 Bathymetric	2 Survey	3 Arr. CCIW 1330 hrs.	4 CCIW
	5 CCIW	6 Dep. CCIW 0900 hrs.	7 Lake Ontario	8 Bathymetric	9 Survey	10 Arr. CCIW 1220 hrs.	11 CCIW
NOV	12 CCIW	13 CCIW	14 CCIW	15 Dep. CCIW 0903 Lake Ontario	16 Met. Buoys Arr. CCIW 1845	17 CCIW	18 CCIW
	19 CCIW	20 Dep. CCIW 0903 hrs.	21 Lake Ontario	22 Moorings	23 Lake Ontario	24 Moorings	25 Arr. CCIW 1448 hrs.
	26 CCIW	27 Dep. CCIW 1100 hrs.	28 Lake Ontario	29 Bathymetric Survey	30 and	1 Decca Calibration	2 Arr. CCIW 1225 hrs.
	3 CCIW	4 CCIW	5 Dep. CCIW 1354 hrs.	6 Lake Ontario	7 Heat Content Survey	8 and	9 Met. Buoy Recovery
DEC	10 Arr. CCIW 0145 hrs.	11 Dep. CCIW 1204 hrs.	12 Lake Ontario	13 Heat Surveys and	14 Met. Buoy Recovery	15 Arr. Toronto 1112 hrs.	16 CCIW
	17 CCIW	18 Dep. CCIW 1306 hrs.	19 Lake Ont. Heat Content Survey	20 Arr. CCIW 2055 hrs.	21	22	23
	24	25	26	27	28	29	30

Table 6. Great Lakes studies, IFYGL, 1972. CSS LIMNOS.

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
FEB	30	31	1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
MAR	27	28	29	1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16 Dep. CCIW 0800 Arr. CCIW 1700	17 CCIW	18 CCIW
	19 CCIW	20 Dep. CCIW 0800 Lake Ontario	21 MOSES Arr. CCIW 1700	22 CCIW	23 CCIW	24 CCIW	25 CCIW
	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1 CCIW
APR	2 CCIW	3 CCIW	4 CCIW	5 Dep. CCIW 0845 hrs.	6 Lake Ontario	7 Met. Buoys	8 Lake Ontario
	9 Met. Buoys	10 Lake Ontario	11 Arr. CCIW 1930 hrs.	12 CCIW	13 CCIW	14 CCIW	15 CCIW
	16 CCIW	17 In Transit	18 Dep. Cobourg 0600 hrs.	19 Lake Ontario	20 Met. Buoys	21 Lake Ontario	22 Met. Buoys
	23 Lake Ontario	24 Met. Buoys	25 Arr. CCIW 1600 hrs.	26 CCIW	27 CCIW	28 CCIW	29 CCIW
MAY	30 Dep. CCIW 0700 hrs.	1 Lake Ontario	2 Met. Buoys	3 and F.T.P.	4 Arr. CCIW 1700 hrs.	5 CCIW	6 CCIW
	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
	14 CCIW	15 Dep. CCIW 0915 hrs.	16 Lake Ontario	17 Met. Buoys	18 and F.T.P.	19 Arr. CCIW 1600 hrs.	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 Dep. CCIW 0845 hrs.	30 Lake Ontario	31 Met. Buoys	1 Lake Ontario	2 Arr. CCIW 2045 hrs.	3 CCIW
JUNE	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
	11 CCIW	12 Dep. CCIW 0905 hrs.	13 Lake Ontario	14 Met. Buoys	15 Lake Ontario	16 Arr. CCIW 2045 hrs.	17 CCIW
	18 CCIW	19 CCIW	20 Dep. CCIW 1020 Lake Ontario	21 Pesticide Monitor	22 Arr. CCIW 1830 hrs.	23 CCIW	24 CCIW
	25 CCIW	26 Dep. CCIW 1015 Arr. CCIW 1930	27 Dep. CCIW 1015 hrs.	28 Lake Ontario	29 Met. Buoys	30 Lake Ontario	1 Arr. CCIW 0100 hrs.
JULY	2 CCIW	3 CCIW	4 CCIW	5 Dep. CCIW 0810 Lake Ontario	6 Pesticide Monitor	7 Arr. CCIW 1845 hrs.	8 CCIW
	9 CCIW	10 Dep. CCIW 0855 hrs.	11 Lake Ontario	12 Pesticide	13 Monitor	14 Arr. CCIW 1615 hrs.	15 CCIW
	16 CCIW	17 Dep. CCIW 0900 Lake Ontario	18 NTA Monitor Arr. CCIW 1030	19 CCIW	20 CCIW	21 CCIW	22 CCIW
	23 CCIW	24 Dep. CCIW 0840 hrs.	25 Lake Ontario	26 Met. Buoys	27 and F.T.P.	28 Arr. CCIW 1530 hrs.	29 CCIW
AUG	30 CCIW	31 CCIW	1 Dep. CCIW 0945 hrs.	2 Lake Ontario	3 F.T.P. and IRLS	4 Arr. CCIW 0300 hrs.	5 CCIW
	6 CCIW	7 CCIW	8 Dep. CCIW 1050 hrs.	9 Lake Ontario	10 Met. Buoys	11 and F.T.P.	12 Arr. CCIW 1815 hrs.
	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 Dep. CCIW 0915 Lake Ontario	19 NTA Monitor Arr. CCIW 1920
	20 CCIW	21 Dep. CCIW 0905 hrs.	22 Lake Ontario	23 Met. Buoys and F.T.P.	24 Arr. CCIW 1730 hrs.	25 CCIW	26 CCIW
	27 In Transit	28 Dep. Kings- ville 0735	29 Lake Erie	30 Iron-Manganese Study	31 Arr. Port Colborne 1935	1 In Transit	2 CCIW
SEPT	3 CCIW	4 CCIW	5 Dep. CCIW 0900 hrs.	6 Lake Ontario	7 Met. Buoys	8 Lake Ontario	9 Met. Buoys
	10 Arr. CCIW 0130 hrs.	11 CCIW	12 Dep. CCIW 0945 hrs.	13 Lake Ontario	14 F.T.P.	15 Arr. Oshawa 1215 Dep. Oshawa 1230	16 NTA Monitor Arr. CCIW 1230
	17 CCIW	18 Dep. CCIW 1010 hrs.	19 Lake Ontario	20 Met. Buoys	21 and F.T.P.	22 Lake	23 Ontario
	24 Arr. CCIW 1520 hrs.	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW
OCT	1 CCIW	2 Dep. CCIW 0910 hrs.	3 Lake Ontario	4 Met. Buoys	5 Lake Ontario	6 Arr. Kingston 0900 hrs.	7 Kingston
	8 Kingston	9 Kingston	10 Dep. Kingston 1315 hrs.	11 Lake Ontario Met. Buoys	12 Arr. CCIW 1700 hrs.	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 Dep. CCIW 0935 hrs.	20 Lake Ontario	21 Met. Buoys
	22 Lake Ontario	23 Met. Buoys	24 Arr. CCIW 1630 hrs.	25 Dep. CCIW 0900 Lake Ontario	26 NTA Monitor Arr. CCIW 1130	27 CCIW	28 CCIW
NOV	29 CCIW	30 Dep. CCIW 0945 hrs.	31 Lake Ontario	1 Met. Buoys	2 Lake Ontario	3 Arr. Kingston 1000 hrs.	4 Kingston
	5 Kingston	6 Dep. Kingston 0700 hrs.	7 Lake Ontario Met. Buoys	8 Arr. CCIW 1430 hrs.	9 CCIW	10 CCIW	11 CCIW
	12 CCIW	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 CCIW
	19 CCIW	20 CCIW	21 Dep. CCIW 0930 Lake Ontario	22 NTA Monitor Arr. CCIW 1920	23 CCIW	24 CCIW	25 CCIW
	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	1 CCIW	2 CCIW
DEC	3 Dep. CCIW 0800 hrs.	4 Lake Ontario	5 Kingston	6 Kingston	7 Met. Buoys	8 Arr. CCIW 2400 hrs.	9 CCIW
	10 CCIW	11 Dep. CCIW 0900 Arr.Niagara 1500	12 Dep. Port Dal- housie 1030	13 Lake Ontario NTA	14 Arr. CCIW 1535 hrs.	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30

Table 7. Great Lakes studies, IFYGL, 1972. MV LAC ERIE.

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
FEB	30	31 Dep. Toronto 1055 hrs.	1 Lake Ontario	2 Monitor	3 Lake Ontario	4 Monitor	5 Lake Ontario
	6 Monitor	7 Lake Ontario	8 Monitor	9 Lake Ontario Monitor	10 Arr. Toronto 1955 hrs.	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
MAR	27	28	29	1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30	31	1
APR	2	3	4 Dep. Toronto 0936 hrs.	5 Lake Ontario	6 Heat Content	7 Survey	8 Arr. Toronto 0010 hrs.
	9	10 Dep. Toronto 0938 hrs.	11 Heat Content Survey, L.Ont.	12 Arr. Toronto 1450 hrs.	13	14	15
	16	17 Dep. Hamilton 0620 hrs.	18 Heat Content Survey L.Ont.	19 Arr. Toronto 1610 hrs.	20	21	22
	23	24 Dep. Toronto 0927 hrs.	25 Heat Content Survey L.Ont.	26 Arr. Toronto 1517 hrs.	27	28	29
MAY	30	1 Dep. Toronto 0945 hrs.	2 Heat Content Survey L.Ont.	3 Arr. Toronto 1617 hrs.	4	5	6
	7	8 Dep. Toronto 0955 hrs.	9 Heat Content Survey L.Ont.	10 Arr. Toronto 1625 hrs.	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29	30	31	1	2	3
JUNE	4	5 Weigh Anchor, Oshawa, 1705	6 Lake Ontario	7 Heat Content Survey	8 Arr. Toronto 0010 hrs.	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26 Dep. Port Colborne, 2255	27 Lake Erie	28 Monitor	29 Lake Erie Monitor	30 Arr. Windsor 0725 hrs.	1
JULY	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
AUG	30	31	1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
SEPT	27	28 Dep. Port Colborne, 0323	29 Lake Erie	30 Monitor	31 Lake Erie Monitor	1 Arr. Port Colborne 0555	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
OCT	1	2	3 Dep. Toronto 1145 hrs.	4 Lake Ontario Monitor	5 Arr. Toronto 2150 hrs.	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
NOV	29	30	31	1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
DEC	26	27	28	29	30	1	2
	3	4 Dep. Toronto 0755 hrs.	5 Heat Content	6 Survey	7 Lake Ontario	8 Arr. Toronto 0905 hrs.	9
	10	11 Dep. Toronto 1400 hrs.	12 Heat Content Survey	13 Lake Ontario	14 Arr. Toronto 0510 hrs.	15	16
	17	18 Dep. Toronto 0930 hrs.	19 Heat Content Survey L.Ont.	20 Lake Ontario	21 Arr. Toronto 1450 hrs.	22	23
	24	25	26	27	28	29	30

Table 8. Great Lakes studies, IFYGL, 1972. CCGS PORTE DAUPHINE.

from the mechanical installation and recovery of towers and moorings to the selective sampling and description of the sediment/water interface. In preparation for the field season, a diving course (arranged and instructed by the Senior Diving Officer) was held at CCIW in February and March. The eight successful candidates represented the Technical Operations, Engineering and Scientific Divisions of the Centre.

A commercial diving team was also contracted to help meet the ever-increasing demands for diving assistance with CCIW projects.

Personnel

Personnel from the subdivision were assigned to the major and minor ships on a continuing basis throughout the season, and to small craft on shore-based scientific survey parties. In most cases, field operations were mainly undertaken by the Technical Operations staff. They had the responsibility for the multidisciplinary field measurements for Lakes Research Division, including all technical deck operations entailing sampling procedures, rigging, launching and recovery of moorings, and meteorological observations. In those cases where more specialized analyses were required, members of the staff formed the backup group to assist the appropriate scientists.

Projects based at Oshawa (Dye Diffusion Program) and Niagara-on-the-Lake (Niagara Bar Project) were supported and coordinated by Technical Operations staff. One staff member was seconded to the Descriptive Limnology Section for the duration of the OOPS Program and another continued to support the Lake Erie Shore Erosion program at Point Pelee.

During February, six staff members attended a 2-week course in basic RADAR at George Brown College in Toronto. Another six staff members completed the exam for their Radio/Telephone Operator Certificates.

Seven student assistants were employed by the Sub-division during the height of the field season in the summer months. Most of these were assigned to the major ships to participate in the cruise work.

Miscellaneous

Technical Operations took over the responsibility for maintaining the Lake Ontario Shore Sensor program during the year. They also provided support for the Laser experiments off Scarborough Bluffs, carried out by the University of Toronto who were testing the use of this technique for oil slick detection.

The ships and launches (in cooperation with the Coast Guard) participated in several rescue searches and managed to rescue several small craft from Lake Ontario.

During August, six winners of the Hamilton Regiona Science Fair were given a week cruise on the M.V. MARTIN KARLSEN for a first-hand look at sampling and observa-tional procedures.

SOCIAL SCIENCE RESEARCH SECTION

The Social Science Research Section is responsible for assessing, the sociological, geographical, legal, institutional and economic aspects of human activities related to water quality and water quantity management. During 1972 th section further contributed to the clarification of th different aspects of the problem of heavy metals and othe environmentally hazardous materials, generated basic geo graphical and economic data of the Great Lakes Basins an major tributaries, continued the survey of public attitude and degree of public concern towards the environmenta problems of water quality and evaluated the legal an institutional framework which governs some of the socio economic activities affecting the water resources.

Table 9. Total use of Selected Metals or Metallic Compounds for All Sectors of Ontario Economy*

Metal or Metallic Compound	Total Direct Use	Total Direct Indirect Use	Total Direct-Indirect –Induced Use
	Pounds per $1,000 of total output (All Sectors)		
Cadmium	0.004019	0.009570	0.014755
Chrome metal	0.383215	0.507821	0.839507
Chrome colors	0.230520	0.318316	0.435165
Land metal all forms	5.077714	15.532466	24.629584
Mercury	0.004937	0.022937	0.037236
Zinc metal all forms	1.643346	4.978228	8.486322

*Forty-nine sectors as indicated by the Inter-Industry flow table of the Ontario Department of Treasury and Economics.

The Section participated in the Task Force on th National Water Needs Study and participated in a numbe of joint studies with other units of CCIW. Members of th staff represented CCIW and the Department of the En vironment at the OECD Working Group in detergent Great Lakes Basin Commission, Cross Mission group on th Environmental Contaminants Bill and some other in ternational and national meetings.

Economics of Environmental Quality

Papers on the usage, inventory of sources, consum tion and fate in Canada of lead, cadmium, and seleniu

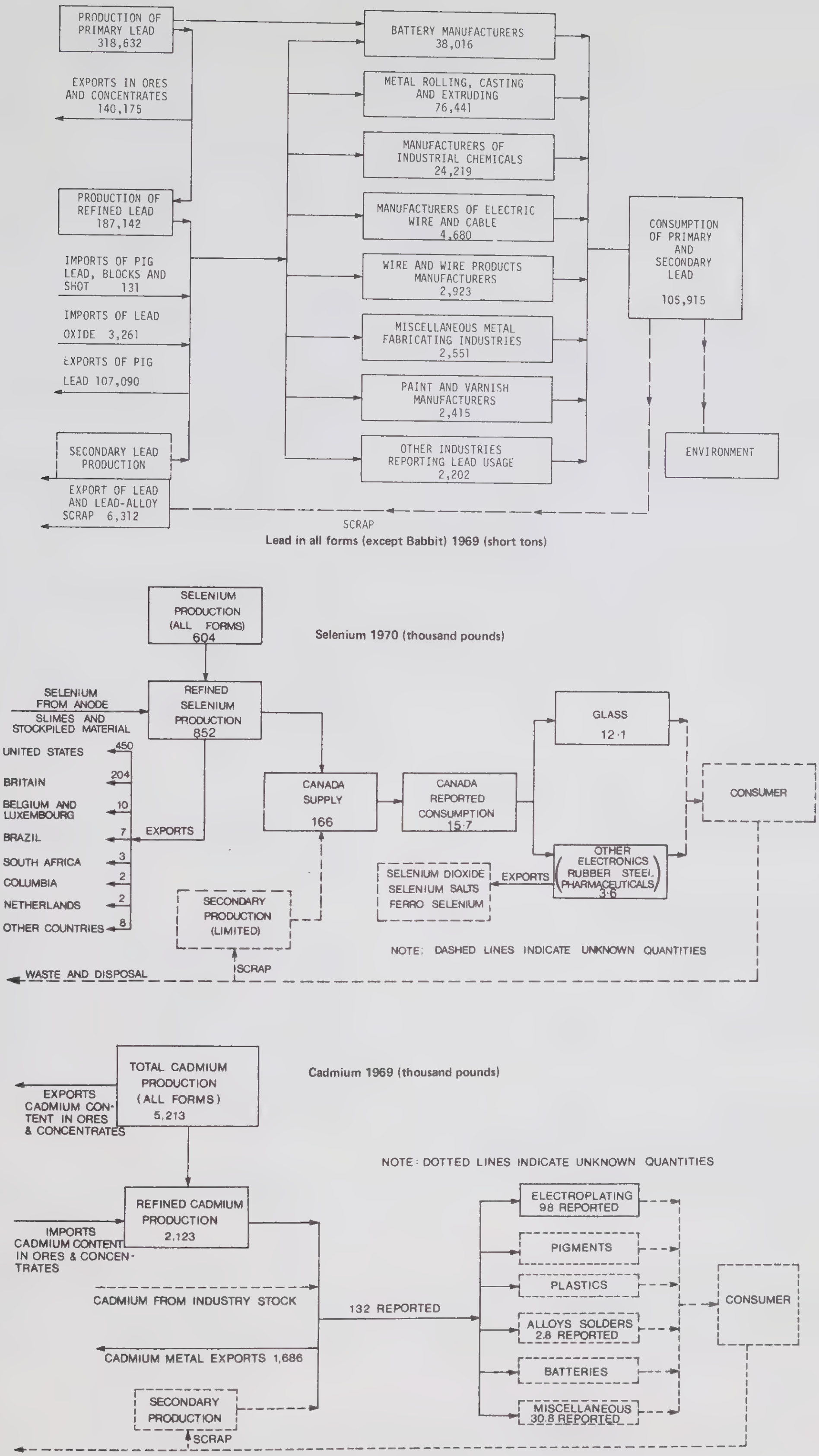


Figure 26. Reported materials flow charts.

Table 10. Preliminary Animal Phosphorus Accumulations – 1971.
(Kilograms)

Drainage Basin	Cattle	Pigs	Sheep	Horses	Poultry	Total
Lake Ontario	4,484,453	2,074,041	70,826	241,760	422,244	7,293,[illegible]
Lake Erie	6,423,254	6,147,313	66,029	231,887	479,761	13,348,[illegible]
Lake Huron	8,219,726	4,240,183	120,498	209,623	389,712	13,179,[illegible]
Lake Superior	86,215	13,512	640	3,306	7,132	110,[illegible]

(Fig. 26) were completed during 1972. The report on the Use of Pest Control products in Canada was also completed. These papers are part of the project on the use of substances which are potentially harmful to the environment, and they represent fundamental information for the second phase of the project which will deal with the analysis of the economics of residuals, cost-benefit analysis of the internalizing procedure and the analysis of the economics of replacing in the production process the heavy metals by less harmful substances. A preliminary step in that direction was achieved with the completion of an input-output table on the use of heavy metals and compounds in the Ontario economy. This table is a matrix of the direct, indirect and induced use of 26 selected metals and metallic compounds by 49 industries representing the Ontario economy (Table 9).

Great Lakes Studies

The task of providing background statistics on the Great Lakes basin was continued during 1972. A report on Population Estimates for the Great Lakes basins and their Major Tributaries for the period 1901-71 was completed.

The Section prepared during 1972 an evaluation of the amount of phosphorus of animal origin accumulated in the river basins of the Great Lakes areas. This information will form part of a report in which statistics on phosphorus loads by river basins and by sources will be shown for the period 1931-71 (Table 10). Analysis of trends, charts and density maps will also be included in the report.

An interesting contribution of the Section to the problem of obtaining data on a drainage basis rather than on a political or administrative basis was the preparation of the map entitled "Great Lakes Basin, Drainage and Political Divisions" (Fig. 27).

Social and Institutional Studies

A survey on the attitudes of municipal officials, both elected and appointed towards the use of renovated waste water and future alternatives of waste treatment was conducted in 11 cities and 3 provinces during the su[illegible] of 1972. The results in general show official reluctan[illegible] consider innovative waste treatment methods and [illegible] deep reliance on traditional secondary treatment me[illegible] and nutrient removal. Although the idea of renovated [illegible] water was often favourably received, it was consider[illegible] the municipal officials as inapplicable to "their cit[illegible]" report of the results, analysis, interpretation and re[illegible] differences will be published in the near future.

A study on Administration of Provincial Water [illegible] Pollution legislation was completed during 1972.

Research on jurisdictional disputes in shoreline [illegible] ning and development and theoretical frameworks [illegible] decision-making systems in resources managemen[illegible] tinued very actively in the Section during 1972.

Miscellaneous

Staff members monitored American public meeti[illegible] shoreline developments and their effects on the Great [illegible] waters.

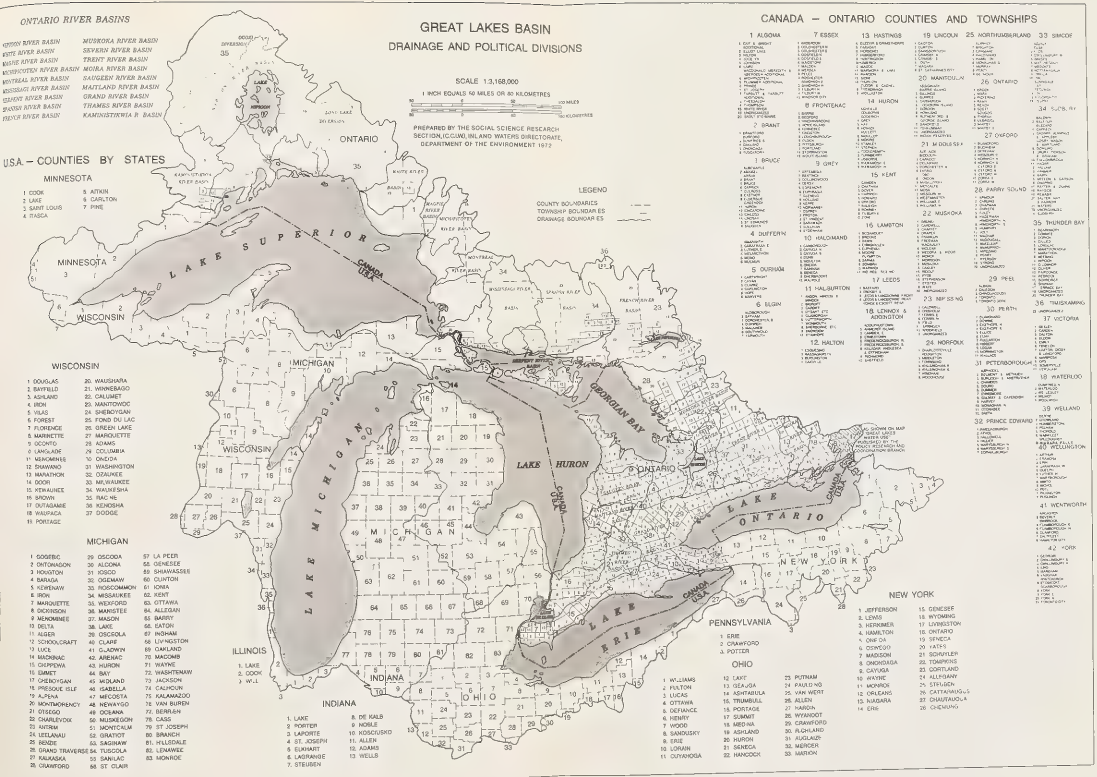
An analysis of the profile and motivations [illegible] visitors to the Open House of the Centre was conduc[illegible] the Section. It was found that while 50.4 percent [illegible] visitors had heard of the CCIW through news medi[illegible] percent knew of its existence because they saw the b[illegible] under construction. 65.5 per cent of those inter[illegible] thought that the main function of CCIW was on [illegible] Research in general while 22.3 percent thought [illegible] pollution research.

The Section participated in planning the NTA N[illegible] Monitoring Program and on the Task Force on N[illegible] Water Needs.

The organization of the CCIW seminar series is [illegible] responsibility of the Section. A number of pros[illegible] speakers were contacted during 1972 in order to e[illegible] diversified and timely program throughout the year.

WATER QUALITY BRANCH RESEARCH

The role of the Water Quality Branch is to collect, interpret and disseminate data and information on water quality for water resource and pollution control studies; to operate and maintain analytical service laborato[illegible] these studies in Canada; and to carry out rese[illegible] analytical methodology on the characteristics and [illegible]


GREAT LAKES BASIN
DRAINAGE AND POLITICAL DIVISIONS
SCALE 1:3,168,000
1 INCH EQUALS 50 MILES OR 80 KILOMETRES
PREPARED BY THE SOCIAL SCIENCE RESEARCH SECTION, (C.C.I.W.), INLAND WATERS DIRECTORATE, DEPARTMENT OF THE ENVIRONMENT 1972
LEGEND
COUNTY BOUNDARIES
TOWNSHIP BOUNDARIES
DRAINAGE BOUNDARIES
ONTARIO RIVER BASINS
NIPIGON RIVER BASIN
WHITE RIVER BASIN
MAGPIE RIVER BASIN
MICHIPICOTEN RIVER BASIN
MONTREAL RIVER BASIN
MISSISSAGI RIVER BASIN
SERPENT RIVER BASIN
SPANISH RIVER BASIN
FRENCH RIVER BASIN
MUSKOKA RIVER BASIN
SEVERN RIVER BASIN
TRENT RIVER BASIN
MOIRA RIVER BASIN
SAUGEEN RIVER BASIN
MAITLAND RIVER BASIN
GRAND RIVER BASIN
THAMES RIVER BASIN
KAMINISTIKWIA R. BASIN
U.S.A. – COUNTIES BY STATES
MINNESOTA
1 COOK
2 LAKE
3 SAINT LOUIS
4 ITASCA
5 AITKIN
6 CARLTON
7 PINE
WISCONSIN
1 DOUGLAS
2 BAYFIELD
3 ASHLAND
4 IRON
5 VILAS
6 FOREST
7 FLORENCE
8 MARINETTE
9 OCONTO
10 LANGLADE
11 MENOMINEE
12 SHAWANO
13 MARATHON
14 DOOR
15 KEWAUNEE
16 BROWN
17 OUTAGAMIE
18 WAUPACA
19 PORTAGE
20 WAUSHARA
21 WINNEBAGO
22 CALUMET
23 MANITOWOC
24 SHEBOYGAN
25 FOND DU LAC
26 GREEN LAKE
27 MARQUETTE
28 ADAMS
29 COLUMBIA
30 ONEIDA
31 WASHINGTON
32 OZAUKEE
33 MILWAUKEE
34 WAUKESHA
35 RACINE
36 KENOSHA
37 DODGE
MICHIGAN
1 GOGEBIC
2 ONTONAGON
3 HOUGHTON
4 BARAGA
5 KEWEENAW
6 IRON
7 MARQUETTE
8 DICKINSON
9 MENOMINEE
10 DELTA
11 ALGER
12 SCHOOLCRAFT
13 LUCE
14 MACKINAC
15 CHIPPEWA
16 EMMET
17 CHEBOYGAN
18 PRESQUE ISLE
19 ALPENA
20 MONTMORENCY
21 OTSEGO
22 CHARLEVOIX
23 ANTRIM
24 LEELANAU
25 BENZIE
26 GRAND TRAVERSE
27 KALKASKA
28 CRAWFORD
29 OSCODA
30 ALCONA
31 IOSCO
32 OGEMAW
33 ROSCOMMON
34 MISSAUKEE
35 WEXFORD
36 MANISTEE
37 MASON
38 LAKE
39 OSCEOLA
40 CLARE
41 GLADWIN
42 ARENAC
43 HURON
44 BAY
45 MIDLAND
46 ISABELLA
47 MECOSTA
48 NEWAYGO
49 OCEANA
50 MUSKEGON
51 MONTCALM
52 GRATIOT
53 SAGINAW
54 TUSCOLA
55 SANILAC
56 ST CLAIR
57 LA PEER
58 GENESEE
59 SHIAWASSEE
60 CLINTON
61 IONIA
62 KENT
63 OTTAWA
64 ALLEGAN
65 BARRY
66 EATON
67 INGHAM
68 LIVINGSTON
69 OAKLAND
70 MACOMB
71 WAYNE
72 WASHTENAW
73 JACKSON
74 CALHOUN
75 KALAMAZOO
76 VAN BUREN
77 BERRIEN
78 CASS
79 ST JOSEPH
80 BRANCH
81 HILLSDALE
82 LENAWEE
83 MONROE
ILLINOIS
1 LAKE
2 COOK
3 WILL
INDIANA
1 LAKE
2 PORTER
3 LAPORTE
4 ST. JOSEPH
5 ELKHART
6 LAGRANGE
7 STEUBEN
8 DE KALB
9 NOBLE
10 KOSCIUSKO
11 ALLEN
12 ADAMS
13 WELLS
OHIO
1 WILLIAMS
2 FULTON
3 LUCAS
4 OTTAWA
5 DEFIANCE
6 HENRY
7 WOOD
8 SANDUSKY
9 ERIE
10 LORAIN
11 CUYAHOGA
12 LAKE
13 GEAUGA
14 ASHTABULA
15 TRUMBULL
16 PORTAGE
17 SUMMIT
18 MEDINA
19 ASHLAND
20 HURON
21 SENECA
22 HANCOCK
23 PUTNAM
24 PAULDING
25 VAN WERT
26 ALLEN
27 HARDIN
28 WYANDOT
29 CRAWFORD
30 RICHLAND
31 AUGLAIZE
32 MERCER
33 MARION
PENNSYLVANIA
1 ERIE
2 CRAWFORD
3 POTTER
NEW YORK
1 JEFFERSON
2 LEWIS
3 HERKIMER
4 HAMILTON
5 ONEIDA
6 OSWEGO
7 MADISON
8 ONONDAGA
9 CAYUGA
10 WAYNE
11 MONROE
12 ORLEANS
13 NIAGARA
14 ERIE
15 GENESEE
16 WYOMING
17 LIVINGSTON
18 ONTARIO
19 SENECA
20 YATES
21 SCHUYLER
22 TOMPKINS
23 CORTLAND
24 ALLEGANY
25 STEUBEN
26 CATTARAUGUS
27 CHAUTAUQUA
28 CHEMUNG
CANADA – ONTARIO COUNTIES AND TOWNSHIPS
1 ALGOMA
2 BRANT
3 BRUCE
4 DUFFERIN
5 DURHAM
6 ELGIN
7 ESSEX
8 FRONTENAC
9 GREY
10 HALDIMAND
11 HALIBURTON
12 HALTON
13 HASTINGS
14 HURON
15 KENT
16 LAMBTON
17 LEEDS
18 LENNOX & ADDINGTON
19 LINCOLN
20 MANITOULIN
21 MIDDLESEX
22 MUSKOKA
23 NIPISSING
24 NORFOLK
25 NORTHUMBERLAND
26 ONTARIO
27 OXFORD
28 PARRY SOUND
29 PEEL
30 PERTH
31 PETERBOROUGH
32 PRINCE EDWARD
33 SIMCOE
34 SUDBURY
35 THUNDER BAY
36 TIMISKAMING
37 VICTORIA
38 WATERLOO
39 WELLAND
40 WELLINGTON
41 WENTWORTH
42 YORK
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
LAKE NIPIGON
CANADA
U.S.A.
ONTARIO
MINNESOTA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
OGOKI DIVERSION
LONG LAKE DIVERSION
AS SHOWN ON MAP "GREAT LAKES WATER USE" PUBLISHED BY THE POLICY RESEARCH AND COORDINATION BRANCH

of substances in water and on water and wastewater treatment.

The elements of the Water Quality Branch at CCIW are partly operational and partly research oriented. Firstly, the Ontario Region operational element, comprising the central analytical service laboratory and a field survey unit, participates in investigations and research studies on the Great Lakes and at other locations in the region. Secondly, the research role at CCIW is carried out by two unitsç one devoted to the development of new and improved analytical methods and the other to new technology for water and wastewater treatment.

ANALYTICAL METHODS RESEARCH SUBDIVISION

The objective of the Analytical Methods Research Subdivision (AMR) is to develop methods of detection and measurement of pollutants in surface waters.

Such methods are then turned over to the WQB analytical service laboratories for routine use. The methods developed are also published in scientific journals to make them available to anyone concerned with the control of water quality.

The AMR Subdivision presently employs 12 research scientists and supporting technicians. The first nucleus of this group moved to the Centre from Ottawa in March, 1972.

During the year analytical research was carried out on some 15 projects. In spite of the disruption caused by the move from one city to another, the research staff managed to publish 6 scientific papers and give a number of conference presentations.

A brief description of the analytical research projects completed or still in progress is given below:

Cyanide Analysis

An automated method was developed for the analysis of cyanides in water. It has a limit of detection of 1 ug/1 CN. Irradiation with ultraviolet light, which decomposes complex cyanides, is used to distinguish between simple and complex cyanides.

Automated Solvent Extraction — Atomic Absorption

A method has been developed for the determination of heavy metals in water by automated solvent extraction — Atomic absorption. This enables such metals as copper and zinc to be measured at a sample rate of 40 per hour with a limit of detection of 0.5 ug/ml.

Colorimetric Determination of Iron

A study was made of the interferences when iron is determined colorimetrically in natural waters by tri-pyridy1-S-triazine. A means was found to overcome these interferences.

Phenol Analysis

Two automated colorimetric methods for the determination of phenolic substances in water have been developed. Both use automated steam distillation followed by colour formation and solvent extraction. One method uses 4-amino-antipyrine, the other 3-methy1-2-benzothiazolinone hydrazone. The limit of detection at a rate of 10 samples per hour is 0.2 ug/1 phenol.

Potentiometric Titrations Using Silver-Sulfide Selective Electrode

The potentiometric titration curves of sulfide, iodide, bromide, chloride, thiocyanide, cyanide, xanthate, mercaptan, thiophosphate, thiosulphate, dithionate, thiocarbonate, thiocarbamate, thioamide and thiourea with Ag, Pb, Cd, Cu and Hg standard solutions using solid state ion-selective electrodes were established. All possible combinations of simultaneous titrations of two compounds were studied. The details on these titrations and the values of Δ E at the equivalence points were provided.

Potentiometric Titrations Using Ammoniumpyrrolidindithiocarbamate Solution

The course of the potentiometric titrations of Ag^{+}, Hg^{2+}, Cu^{2+}, Pb^{2+}, Cd^{2+}, Ni^{2+}, Co^{3+}, Zn^{2+}, Fe^{3+}, Bi^{3+}, and Tl^{3+} ions with ammoniumpyrrolidindithiocarbamate standard solution, using the sulfide-ion selective electrode, was estimated. In addition, simultaneous titrations of possible combinations of tested ions were evaluated.

Automation of Direct Potentiometry

Commonly used methods of direct potentiometry were

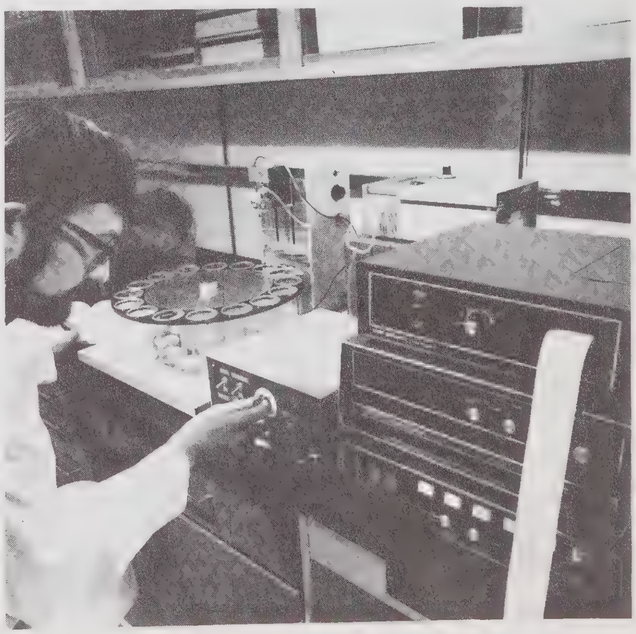


Figure 28. Joe Lechner sets the control for automated potentiometric analysis of ammonia and fluorides.

automated. The automated apparatus consists of a turntable sampler connected to an automatic switch, pH/mV meter and printer system via a control module. The optimum sampling rate is 20 samples/hr. The operation of the apparatus was verified by the determination of fluoride and ammonia in water samples using commercially available ion-selective electrodes.

Automated Determination of Fluoride Ion in Parts per Billion

Fluoride ion, down to 2 ppb, has been determined by automated direct potentiometry using a fluoride ion-selective electrode. The method reduces the dilution and contamination effects of TISAB and takes the electrode time response into consideration. The relative standard deviation in water samples is 1.5 to 1.8% and the recovery varied from 97.5 – 102.0%.

Twin-Cell Voltammetric and Related Techniques for the Analysis of Trace Contaminants

A systematic study is under way to evaluate voltammetric and related techniques, in a twin-cell mode, to device improved methods for analysis of pollutants, and also to obtain information concerning various forms and oxidation states of individual species.

Methods were developed to determine the total content of heavy metals down to 1 ug/litre without preconcentration. Information has also been obtained concerning the forms or oxidation states of these metals.

Methods have also been developed to analyze synthetic chelating agents, such as SHIM, NTA, EDTA, Citric Acid

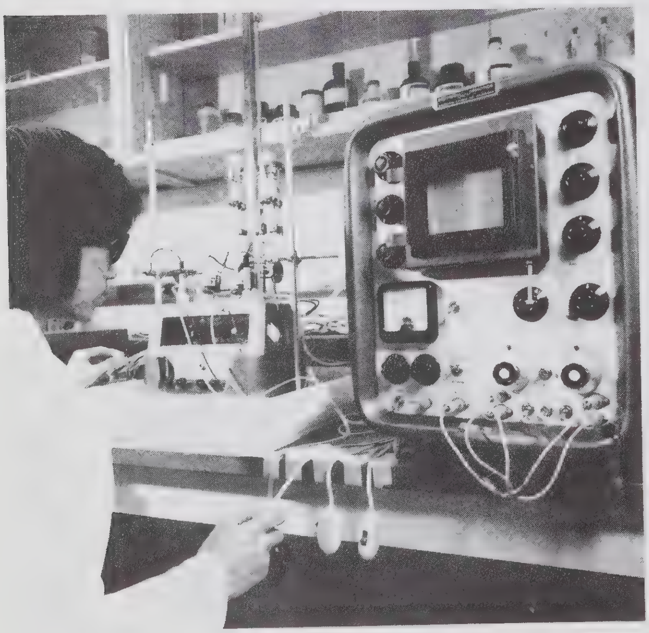


Figure 29. Rickey Leung analyzes synthetic chelating agents in detergents by twin-cell voltammetry.

Figure 30. Mike Comba identifies GC-MS peaks for PCB's and other pesticide residues.

and Polyphosphate, in detergents and natural waters. By automating such methods, these sequestering agents can be determined simultaneously at the rate of 20-30 samples per hour.

Molecular Fluorescent Spectroscopy for the Analysis of Water Pollutants

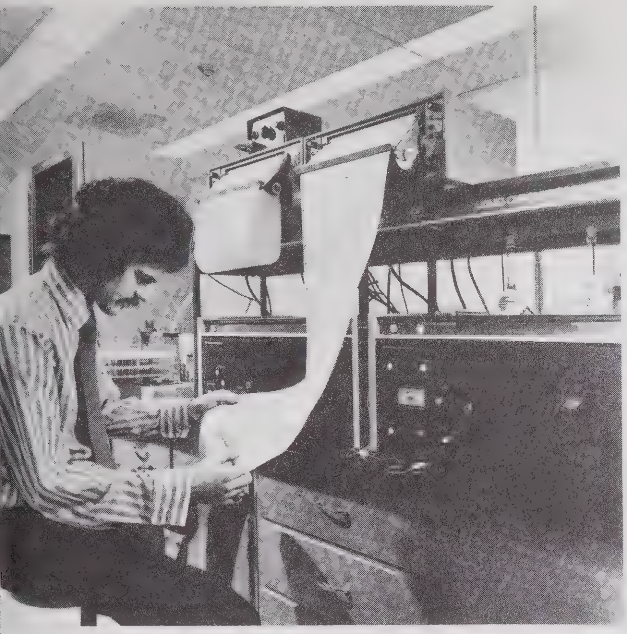
New reagents were developed to determine trace metals, such as Ag, B, Be, Cd, Pb, Cr, V, in natural waters, sewage effluents and sediments. These reagents can also be used to obtain information concerning the oxidation states of the metals. Automated methods were developed for boron and other metals down to 0.5 ug/litre in water and sediment without preconcentration. The maximum sample size needed for the analysis is approximately 1 ml. An analysis rate of 20-40 samples per hour can easily be achieved.

High Speed Liquid Chromatography for Pesticides and Other Organic Compounds

Work is continuing towards developing a new qualitative and quantitative methods for the analysis of organic contaminants using High Speed Liquid Chromatography.

Methods have been developed to separate, identify and measure individual phenolic-type compounds in natural waters and sediments. It is possible to detect and determine individual phenols down to 1 ug/litre.

Work is also continuing to interface various detectors such as electrochemical, flame/atomic and fluorescence, t



igure 31. Richard Larose measures the peaks of a variety of separated phenols by High-Speed Liquid Chromatography.

xtend the potential of the technique to pesticides and ther organic compounds.

tability of Organochlorine Pesticides in Water

Gas Chromatographic methods were employed to etermine the rates of degradation of aqueous solutions of arious organo-chlorine pesticides. Identification of the roduct(s) was made, where possible, and rate constants alculated where applicable.

ias Chromatography of Polychlorobiphenyls

High efficiency gas chromatography employing .C.O.T. columns was used to resolve complex mixtures of olychlorobiphenyl (PCB) isomers. The relative concentrations of all resolvable isomers in a number of ommercially available PCB mixtures are being calculated. queous solutions of these same mixtures will later be xamined for possible alteration or degradation of some of he isomers.

iC – Mass Spectrometer (Mat Data System)

A mass spectral library of PCB's and pesticide residues vas compiled during the year providing analytical support or the Division's laboratories in Moncton, Burlington and Calgary.

Project support was extended to Eldorado Mining and Uniroyal in Guelph with the successful identification of toxic by-products that were being discharged in their wastewater effluents.

WATER AND WASTEWATER TREATMENT RESEARCH SUBDIVISION

It is the responsibility of the Water and Wastewater Research Subdivision to generate new knowledge and evaluate existing knowledge, that can be used to effectively manage the quality of Canada's water resources. This responsibility is met by:

(a) studying chemical and physical methods of quality control by unit processes,

(b) application of scientific information to specific problems,

(c) arranging and administering scientific investigative contracts, and

(d) consulting with industrial environmental personnel, consulting engineers, university staff members and others who are involved with the generation and practical application of scientific information which is aimed at improving or safeguarding water quality.

Some of the studies are conducted in government laboratories; others will be undertaken at problem sites. Some of these studies are conducted under contract.

Effluents from both primary and secondary treatment plants have been analyzed for; BOD, COD, phosphorous and nitrogen, toxic material, heavy metals, radio active material and other exotic and potentially harmfully chemical complexes. Based upon the analysis, potentially successful treatment processes are studied in the laboratory, and then depending upon the laboratory studies, some of these studies are extended and applied to specific wastes.

Six man-years have been assigned to the subdivision. Staffing commenced in October 1972, and by the end of calendar year 1972, four of these positions were either occupied by research scientists or were committed. In addition to the research scientists several technicians and other support personnel were recruited to the subdivision staff during 1972.

Studies that are either in the planning stage or active are in the area of: (a) absorption, (b) ozonation, (c) reverse osmosis, (d) fate and removal of heavy metal, (e) laser application to sewage treatment.

Environmental Protection Service

The Environmental Protection Service was formed to ensure that the Federal Government's legislation, regulations and guidelines concerned with the quality of the environment are approached in a fashion consistent with national policy and enforced under appropriate circumstances. The Environmental Protection Service is involved in the development of guidelines and regulations in the identification and solution of pollution problems, problem surveillance and monitoring, and the development and demonstration of waste control technology. It draws on expertise from the Resource Missions of the Department for the criteria necessary to develop meaningful regulations, guidelines, and codes of good practice and for the conduct of research required to support E.P.S. responsibilities.

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION DIVISION

The Technology Development and Demonstration Division, Technology Development Branch, Water Pollution Control Directorate, is charged with the conception, development, and implementation of technical development programs as related to water pollution control for industrial and municipal wastewaters across Canada. The Division not only undertakes bench and pilot scale studies in their laboratories but also participates in field demonstration projects at industrial sites.

To fulfill the mandate of the Technology Development Branch, EPS established a program at the Wastewater Technology Centre at the Canada Centre for Inland Waters (CCIW). The Wastewater Technology Centre is located in a two-storey building at the North end of the CCIW site. The building houses laboratories, and provides 15,000 sq. ft. of working area for a wide variety of modular wastewater and sludge treatment process equipment.

The staff of the Wastewater Technology Centre is organized into four main sections. These are the Process Development Section, Demonstration Section, Laboratory Services Section and Facilities Services Section, all supported by administrative personnel.

PROCESS DEVELOPMENT SECTION

The Process Development Section comprises five units organized along process lines: (1) biological processes, (2) physical processes, (3) chemical processes, (4) soil processes, and (5) process control.

Biological Processes Unit

This group is responsible for examining the biological and microbiological aspects of water pollution control systems, e.g. nitrificationdenitrification, activated sludge systems, anaerobic and aerobic digestion processes, and for toxicity and biodegradability studies.

Pulp and Paper Mill Effluent Treatment

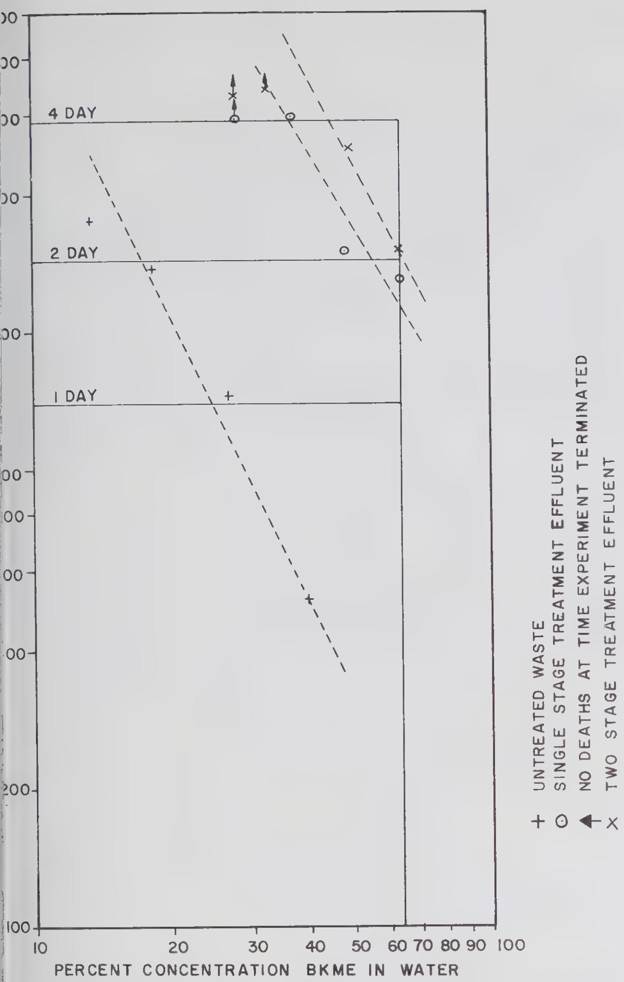
Environment Canada in November 1971, published the Pulp and Paper Effluent Regulations to control BOD, suspended solids and toxicity of pulp mill effluents. Biological treatment by activated sludge is known to be effective in reducing BOD and suspended solids and to partially reduce the acute toxicity of Bleached Kraft Mill effluents (BKME). A study to determine in Kraft Bleachery waste could be successfully treated in a high rate, two stage biological reactor system was initiated. Comparisons were made between the efficiency of a two-stage and a single stage process.

Weekly samples of Kraft Bleachery waste were shipped from a pulp mill in Northern Ontario. The waste was fed to the two biological processes and the treated effluent used for acute toxicity studies on Rainbow trout.

At organic loadings up to 1.2 kg BOD_5/kg MLSS, 90% BOD_5 reduction was achieved. Under these conditions th total aeration time for the single and two-stage system were 1.7 hours. The overall system detention times in bot cases were 3.9 hours. Biological treatment of bleacher waste was only partially successful in reducing acut toxicity. Generally, the bench scale project indicated tha biologically treated effluent was from 3 to 4 times le toxic than raw effluent.

Continuous Biological Denitrification of Wastewater

A nitrification/denitrification pilot plant program (gpm) was carried out in conjunction with McMast University in 1972 to investigate the feasibility of usir continuous microbial denitrification for nitrate remov from municipal wastewater under cold temperatures. U flow packed column reactors and column reactors and stirred tank reactor provided denitrification using methan as an external carbon source. The denitrification units we designed to allow calculation of a nitrogen balance.



gure 32. A toxicity curve comparing the survival time of 50% of the exposed population to concentrations of: (a) untreated Bleached Kraft Mill effluent (BKME); (b) treated BKME in a single-stage AS plant; (c) treated BKME in a two-stage AS plant.

The experimental temperature range was 5–25° C. Comarisons were made between the quality of the effluent om the upflow column reactors and the stirred tank actor in terms of nitrate plus nitrite concentration and ispended solids concentration. Predictions of the stirred nk effluent from resulting batch unit rate data were iade. The unit rate data were derived from batch runs irried out in the pilot plant stirred reactor. These results nd the continuous operational data indicate the definite ependency of nitrate plus nitrite removal on temperature. he importance of proper addition of the external carbon ource in order to ensure minimal effluent organic carbon as demonstrated. Nitrogen balances were obtained on the olumn units and the stirred tank under the various perational conditions.

ircraft De-Icer Studies

An experimental program is being conducted to deermine the biodegradability of aircraft de-icers used at anadian airports. Continuous bench scale biological rector studies and pilot plant studies are being conducted at low temperatures using mixtures of de-icer and sanitary sewage that might be encountered at any Canadian airport. Various concentrations of de-icer and treatment plant effluents are being subjected to bioassay tests to determine their toxicity.

Soil Processes Unit

The chief area of responsibility of this group is in investigating methods suitable for the disposal of effluents and chemical sludges using soil systems. Areas of concern consist of characterizing the leachate from the sludge-oil system and the role different soil systems play in removing various constituents.

Environmental Effects of Chemical Sludge Disposal on Land — Lysimeter Studies

This project was initiated and supported under the Canada/Ontario Agreement in 1972. An environmentally-controlled facility, accommodating sixty-six fibreglass lysimeters, six feet high and one foot in diameter has been erected at the Wastewater Technology Centre. Fifty-four treatment lysimeters and twelve control units have been filled and packed with sandy loam soils collected from the Hespeler and Guelph-Flora Research Station. The lysimeters have been packed to the natural field density and each soil system has been set with three horizontal materials. An extensive program is underway to study: the biochemical degradation of sludges in different soil systems for nutrients and trace metals with their residual effects on physico-chemical properties of soils and leachate systems; the transport and complexing of organic and inorganic constituents of chemical sludges in soil and leachate; the performance and efficiency of two soil systems; and the survival, longevity and transmittal of pathogens and viruses in soils and leachate.

Biochemical Characterization of Chemical Sewage Sludges

With the mandatory removal of phosphorus from sewage and the increasing use of alum, ferric chloride and lime to precipitate phosphorus, large quantities of organo-chemical sludges will be produced in Ontario each year, with a wide variation in characteristics, due to different chemicals, different treatment processes, different sludge handling practices and different seasonal operations.

To establish disposal criteria, environmental contamination standards and waste management practices, studies are underway to assess the chemical variability of sludges due to the use of the three principal precipitation chemicals; to evaluate the microbial characteristics and variations; and to establish the value of different sludges as fertilizers.

Recycling and Utilization of Digested Sewage Sludge and Effluents on Land — Iona Island, Vancouver

A three year study program is underway to investigate the disposal of digested sewage sludge and effluent on land

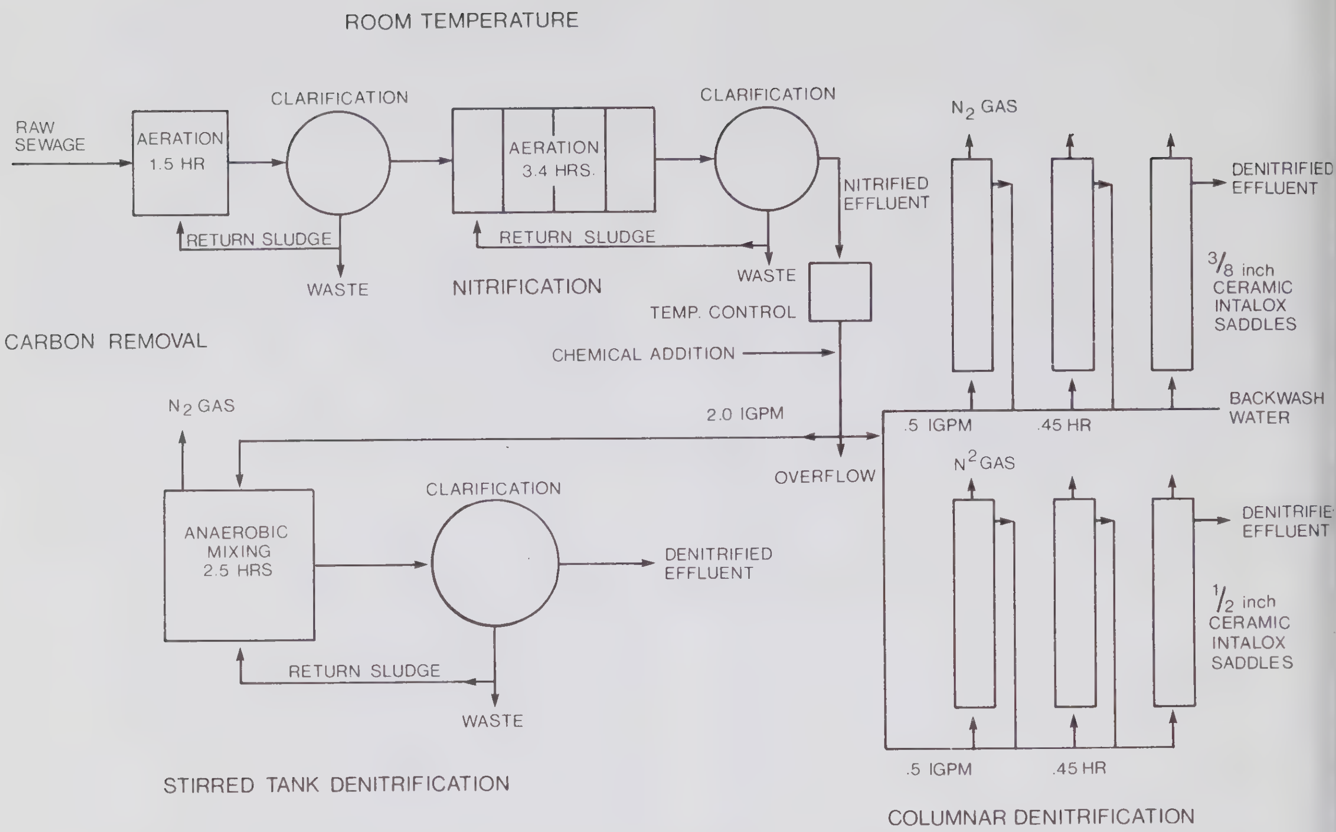


Figure 33. Flow diagram of 4300 IGPD Nitrification – Denitrification Pilot Plant.

to obtain a comprehensive understanding of environmental effects on soil, plant, groundwater and public health.

The experiments are being conducted in sands piped from the Fraser River on which Reed canary grass, oats and a forage crop will be grown on a three year rotational cycle.

Chemical Processes Unit

This group carries out developmental work in chemical processes for the removal of undesirable and potentially harmful constituents from effluent waste streams. Of emmediate concern and involvement is the removal of phosphates by chemical means.

The Detergent Substitution Study at C.F.S. Gloucester

Canadian Forces Station (CFS) Gloucester was the site of full-scale detergent substitution studies. Wastewater characteristics and sewage treatment plant performance were monitored under baseline (consumers using existing detergent formulations), NTA, carbonate, high-phosphate and citrate detergent substitution conditions. Specific objectives of the program included: (1) to determine the degradability of NTA and citrate when subjected to biological treatment, (2) to determine the relationships between detergent formulations and phosphorus removal with calcium, iron and aluminum salts, and (3) to assess consumer attitudes towards the various detergent formula-tions.

It was found that the substitution of non-phosphat[e] detergents for existing detergents (phosphate content les[s] than 20% as P_2O_5) resulted in an average reduction of 24[%] in the total phosphorus loading of the domestic wastewate[r]. Figure 35 shows the effect of the various formulations o[n]

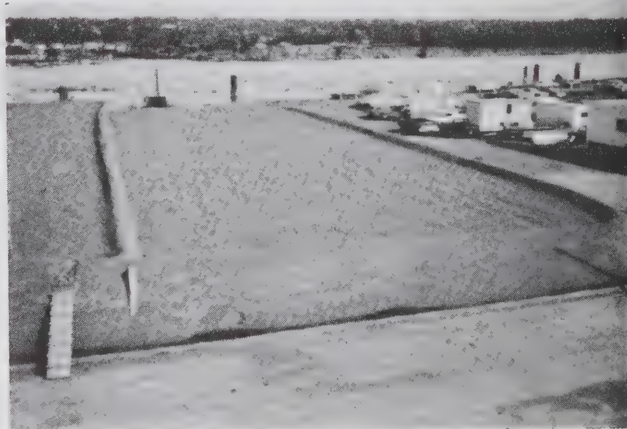


Figure 34. Sludge disposal experiment, Iona Island, Vancouver.

otal phosphorus levels in the sewage from the married uarters area.

NTA was significantly degraded (60-75% removal), whereas citrate was essentially completely degraded (> 95% emoval) by the activated sludge treatment process. Detergent induced increases in NTA and citrate did not ave any quantifiable effect on phosphorus removal with lum, ferric chloride or lime. In fact, the reduction in wastewater phosphorus levels resulted in a corresponding eduction in the dosage of alum and ferric chloride required o achieve a residual phosphorus level of 1 mg/1. It was stimated that complete substitution of phosphate-based etergents may result in a 25-30% reduction in coagulant equirements.

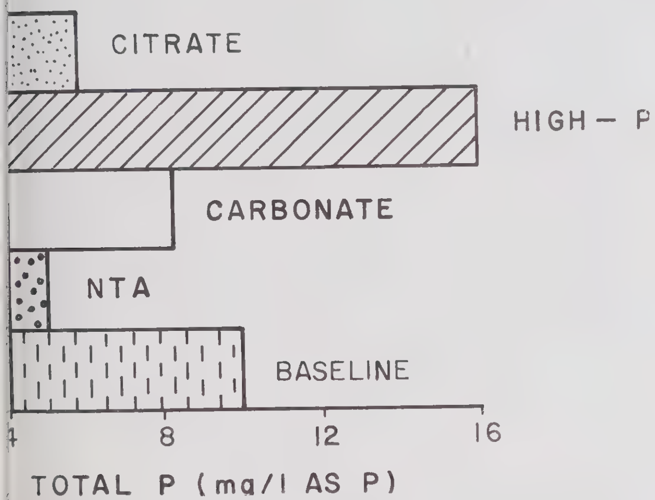


Figure 35. Comparison of total phosphorous concentrations in married quarters' wastewater for five detergent conditions.

Water Quality Control Experiments on the Welland Canal

The existing (fourth) Welland Canal will be replaced by the new (fifth) Welland Canal in the Spring of 1973. In order to evaluate water quality control alternatives for the abandoned canal, the St. Lawrence Seaway Authority and the Environmental Protection Service initiated a demonstration study in May, 1972, on four basins located in a stretch of the third Welland Canal. One basin was treated with aluminum sulphate (alum) at a dosage of 5 mg/1 as Al; another basin was maintained as a controlled flowthrough situation (4-day retention time); a third basin was treated with copper sulphate at a dosage of 1 mg/1 and the fourth basin was used as a control.

The biological, chemical and physical characteristics of the basins were monitored on a weekly basis from May to August, 1972. Specific water quality comparisons between basins were made with respect to total phosphorus, chlorophyll *a*, primary production, turbidity, sediment characteristics and heavy metals. Although nuisance conditions (algal blooms) did not develop in any of the

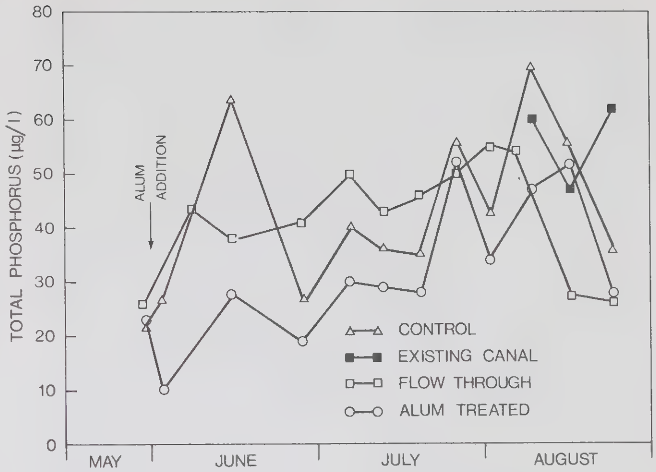


Figure 36. Total phosphorus variations in Welland Canal test basins (May-August 1972).

experimental basins, there were significant inter-basin water quality differences — for example, note total phosphorus variations in the basins for the period May to August, 1972, in Figure 36.

Availability and Quality of Chemical Precipitants for Phosphorus Removal

This project, funded under the Canada-Ontario Agreement on the Lower Great Lakes, was initiated to assess the location and quality of industrial wastes or by-products (pickle liquors, mill-scales, carbide limes, etc.) which have potential usefulness for phosphorus removal. An inventory of such waste sources in Ontario and Quebec has been prepared and preliminary testing has identified several wastes that are capable of efficient phosphorus removal (either in an as-is condition or, in some cases, a reprocessed state). Specific studies of the effects of pickle liquor additions on (i) the activated sludge process and (ii) sewage plant effluent heavy metal (e.g., chromium and zinc) are also being conducted.

Physical Processes Unit

The responsibilities of this group consist of process development in the domain of physical processes such as settling, filtration, aeration, flotation and mixing, and sludge dewatering and handling.

Unslake Lime — Its Direct Use in Phosphate Removal Processes

A study of the use of dry unslake lime (quicklime) in the primary treatment of sewage was carried out to demonstrate the feasibility of using the chemical for phosphorus removal. The 30,000 IGPD pilot plant which was constructed in the Wastewater Technology Centre was operated for a year to establish design criteria for quicklime systems and compare the phosphorus removal efficiency and economics of this process with conventional processes using slurried hydrated lime.

Comparisons between quicklime and hydrated lime for the low lime system (pH 9.5-10), low lime system with sludge recycle, high lime system (pH > 11) and the high lime system with sludge recycle, have shown that removals of phosphate using quicklime was equal to hydrated lime when equivalent amounts of chemicals were used (on a CaO content basis). A process for adding the quicklime to the rapid mix tank of a waste treatment plant was developed and operated without failure during the project. The unit consists of a storage hopper, a continuous slaking reactor and slurry storage and pumping unit. The system includes process control to establish the dry quicklime feed rate, water to quicklime ratio and reaction temperature to ensure a uniform supply of lime of the desired quality and the complete reaction ofthe quicklime with the water. The use of such a quicklime system should reduce the operating cost for lime-phosphate treatment by approximately 30% and the capital cost by approximately 10%.

New Brunswick Acid Mine Drainage Treatment Program

In 1972, a joint Federal/Provincial/Industrial study was initiated for the development of mine wastewater treatment

Figure 37. Installation of clarifier in the Quicklime Pilot Plant.

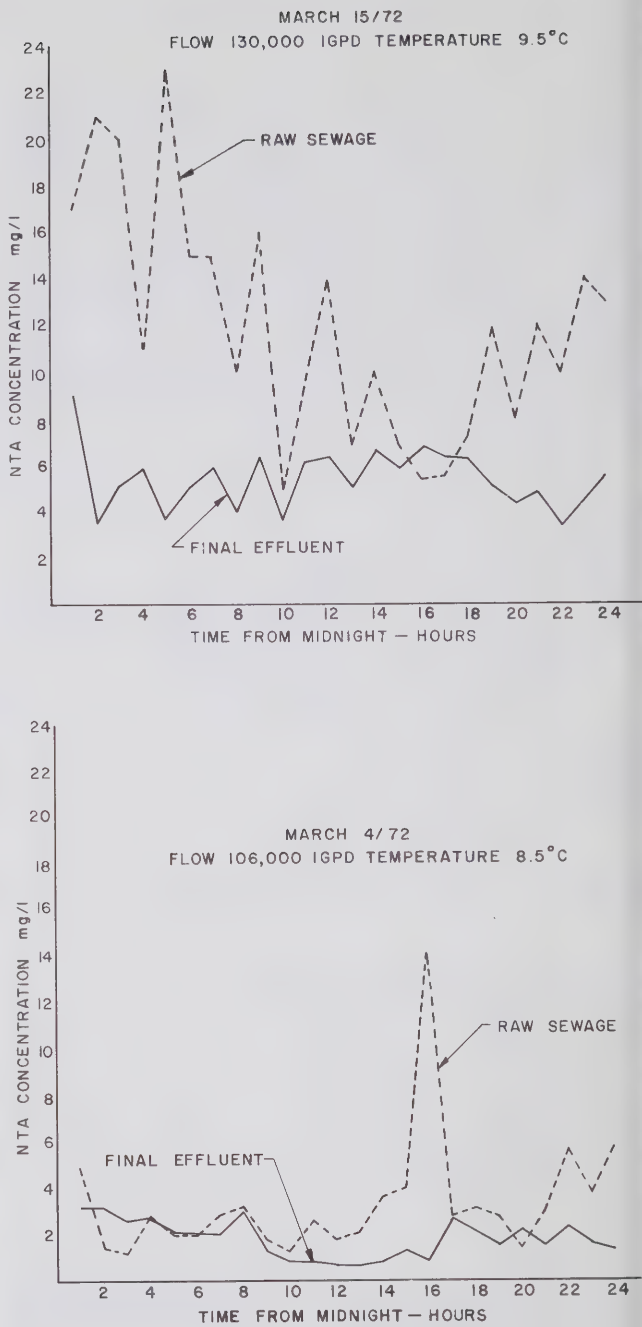


Figure 38. NTA in influent and effluent waters of the Waterdow Wastewater Treatment Plant.

technology in the base metal mining industry. As a result, waste treatment pilot demonstration plant is beir established at the Brunswick Mining Company site i northeastern New Brunswick. The plant data obtained wi be a cornerstone in the development of national pollutio abatement guidelines for the mining industry and shoul provide a treatment process to enable the mining of coppe lead and zinc to co-exist with salmon fishing of nort eastern New Brunswick.

The unit has developed a flexible and versatile pilot plant system which incorporates state-of-the-art technology for treatment of such acidic wastewaters. Unit processes included are thiosulfate stabilization, neutralization and precipitation, sedimentation, sludge handling and effluent polishing.

In support of the field program, bench scale studies have been carried out to assess the feasibility of various processes and to narrow the experimental range of the studies to be undertaken in the field with the pilot plant. Bench scale studies on a high-density sludge process have shown that the maximum effluent quality obtainable with lime or limestone lime precipitation systems is approximately lmg Zn/1 and 0.2 mg Cu/1. These levels do not meet the proposed guidelines. Thus, studies have been undertaken to assess various effluent polishing processes such as sand filtration, ion exchange, cementation on aluminum and magnesium metals, and ion exchange with silicon alloys to provide better removals. Excellent results have been obtained for several of the processes and trials at the pilot scale are under consideration for the field installation.

Sludge Dewatering and Reduction Processes

An extensive program is underway to investigate sludge dewatering processes with respect to he characterization of sludges and the effect of type of sludge and chemical treatment on physical properties; the determination of parameters and properties governing dewatering processes; and the prediction of plant operation from laboratory determined physical properties and pilot plant operation.

Extensive experimental work has been carried out on the development and assessment of sludge characterization parameters. They include: bulk properties — settling, rheology, compressibility, filterability, specific resistance, compressibility, and capillary suction time; continuous phase properties — viscosity surface tension, TDS and density; and dispersed phase properties — particle sizes and distribution, zeta potential, nature of particulate material (granumetric property), surface charge and bound water.

DEMONSTRATION SECTION

The Demonstration Section implements and monitors experimental programs in the field.

Maritime Fish Processing Study

The Section participated in a study of fish processing plants located in Nova Scotia, New Brunswick and Newfoundland. The effluents from these plants were studied to determine waste characteristics and water usage in the ground fish filleting, whale slaughtering and sardine canning processes. Effluent loadings per 1000 pounds of ground fish and final product were determined from experimental data, flow measurements and production figures. The results will form part of the data base for writing the effluent guidelines for the fish processing industry.

Waterdown Wastewater Treatment Plant NTA Study

A field study was carried out during the winter of 1971-72 and 72-73 at the Waterdown Wastewater Treatment Plant to assess the impact of NTA on chemical treatment phosphorus removal facilities and treatment plant operation. The studies also investigated NTA degradation and the effect of NTA loading on heavy metal transport through the treatment plant.

The biological, chemical and physical characteristics of the plant were monitored on a daily basis for 12 months. It was found that NTA loading had no effect on the chemical dosages required for phosphorus removal. NTA was significantly degraded on passage through the treatment plant; however, the removal was influenced significantly by wastewater temperature and NTA influent concentration to the treatment plant (see Figure 38). Heavy metal transport through the treatment plant increased with increased NTA loading to the plant.

Combined Sewers

Over the past ten months, in conjunction with the Hydraulics Division, IWD, an extensive survey of the literature was carried out to assess combined sewer overflows to outline a research strategy and to develop technology for the problem and the approach to be taken. Recommendations were put forth on strategy to be followed within the Canada/Ontario Agreement in addressing the problem of combined sewer overflows in Canada.

LABORATORY SERVICES SECTION

Early in the year, the section moved to a permanent location in the Wastewater Technology Centre where increased space permitted the installation of new automated analyzers and atomic absorption spectophotometric facilities. This new equipment was immediately placed to

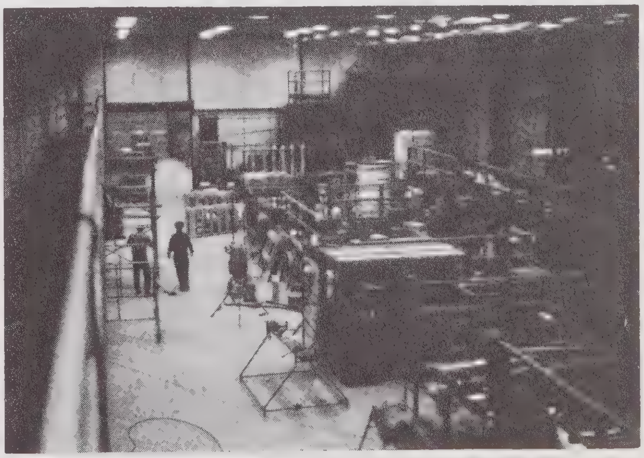


Figure 39. Fixed process mechanical and electrical systems for waste treatment pilot plants.

Figure 40. Extended Aeration Pilot Plant.

provide analytical support to the bench scale, pilot plant and field projects in which the Division is engaged.

Throughout the year, heavy demands were placed on all available facilities and manpower to meet analytical requests. Analyses performed were largely confined to the various forms of the C, N, P nutrients and heavy metals, mainly in samples of a domestic sewage type. However, there was increasing demand for analyses (for similar parameters) on samples of the biological and chemical sludges produced by various treatment processes and soils. More than 16,000 samples were processed during the year for a total of more than 50,000 parameters.

FACILITIES SERVICES SECTION

The Facilities Services Section operates and maintains the various pollution control process units in the Wastewater Technology Centre and ensures that new pollution control process hardware is assembled according to designs generated by the Process Development Section.

Construction and installation of the fixed process piping, waste storage, electrical and control systems was accomplished in 1972. An observation deck was added to the second floor, opposite the working mezzanine, to permit scientists to make immediate contact with operations in the plant and to provide an area for the general public to see the facilities.

Fish culture and bioassay capacity was increased by an extension to the environmental room facilities.

Numerous pilot plant unit processes, such as reverse osmosis, vacuum filters, clarifiers, centrifuges, a calcinator and a multiplehearth furnace were procured and assembled in the Wastewater Technology Centre.

Significant construction and installation was carried out on the north side of the Wastewater Technology Centre to provide electrical, air, water, sewage and drainage services. A twenty-gallon-per-minute extended package plant has been installed on the prepared site, along with an air-conditioned moveable test building that accommodates soil lysimeters for experiments on land disposal of chemical sludges.

ENVIRONMENTAL EMERGENCY BRANCH

The Environmental Emergency Branch (EEB) which is part of the Environmental Protection Service, is responsible for protective and preventative activities where an environmental threat results from an accident in which a hazardous chemical is released into the environment. EEB is represented at CCIW by the Hazardous Material Spill Countermeasures Unit and the Environmental Emergency Coordination Unit.

Hazardous Material Spill Countermeasures Unit

The Hazardous Material Spill Countermeasures Unit is the national centre for evaluation and development of countermeasures systems for dealing with spills of oil and other hazardous and toxic materials. The primary functions of this unit are the testing and evaluation of current countermeasures equipment, materials and techniques, and the subsequent design and development of a number of effective, economical and ecologically safe, multicomponent control systems to combat spills occurring under various conditions throughout Canada. The unit is further responsible for the development of Federal guidelines for the acceptability and use of oil spill treating agents and techniques.

Since July, 1972, when the unit began operations at CCIW, several projects have been undertaken in liaison with other groups and scientists at the Centre, with industrial companies, with university consultants and with other governmental agencies. Two major projects were completed

Figure 41. Field testing at CCIW of oil spill collection system.

in 1972. These were (1) the testing and evaluation of an oil spill collection system developed (under contract) by Canadair Ltd., and (2) the development of Federal guidelines for the acceptability and use of oil spill dispersants. Current work includes (1) testing and evaluation of several dispersants, (2) feasibility studies of a passive microwave radiometer system for the detection and measurement of oil spills and (3) field testing of chemical oil herders. Planning is underway for extensive testing and evaluation of (1) several absorbent boom products, (2) Lockheed's Clean Sweep oil spill remover and (3) JBF's Dynamic Inclined Plane oil spill removal system.

Great Lakes International Contingency Plan

The Great Lakes International Contingency Plan was officially implemented on the 15th. of April, 1972, with the signing of the Canada-U.S. Agreement by the Prime Minister and the President. The plan was invoked in June as a result of the Parker Evans and Sidney E. Smith collision in the St. Clair at Sarnia. During subsequent recovery operations, the Parker Evans' fuel oil was successfully removed with minimal spillage from the wreck. The event provided experience in operational procedures and communications and resulted in recommendations for improvements to streamline operations. These improvements will be incorporated in a revised plan in 1973.

In late September, an Environmental Emergency Coordinator joined the staff to assist the Director of the Centre as the Great Lakes Regional Co-ordinator. An Operations Centre was established to provide a focal point of major spill reports on the Great Lakes and will aslo act as the contact point for the United States Regulatory Agencies related to matters under the Great Lakes Contingency Plan.

Oil Spill Countermeasures equipment, such as 2000 ft. of oil spill boom and 2 Slicklickers have been located at the Centre. Additional equipment, such as sorbents, generators, floodlights, radios, clothing, small hardware, etc., will be in place before the end of this fiscal year. Similar equipment is also stored at the Ministry of Transport Marine Agencies in Prescott, Amherstburg, Sarnia, Parry Sound and Thunder Bay. The countermeasures equipment will assist the staff to enable them to improve the operational response to future spill incidents.

Fisheries Research Board

The year 1972 was a year of change for the FRB Detachment. This unit, formerly administered by the Freshwater Institute at Winnipeg, was established as a separate responsibility centre with the name, Great Lakes Biolimnology Laboratory. Dr. Arnold Nauwerck, Head, left the group to return to Sweden at the end of January. Dr. Walter A. Glooschenko assumed duties as Acting Head on February 1, and held the position until November 30, 1972. Dr. Murray G. Johnson was appointed as Program Head on December 1st.

The programme of the unit focuses on three main areas. The first of these is Descriptive Biolimnology, led by Dr. Nelson Watson, which includes surveys, surveillance and work on taxonomy and developmental cycles of phytoplankton, zooplankton and bottom fauna in the Great Lakes. Dr. Walter Glooschenko is leading the second area, Environmental Toxicology, with emphasis on the effects of toxic substances such as pesticides and trace metals and of waste heat on aquatic life. The third area, Ecosystem Metabolism, emphasizes primary and secondary production in lakes and effects of environmental stresses on production dynamics. A leader will be appointed in early 1973.

During 1972, the major effort of the unit was the IFYGL programme on Lake Ontario with emphasis upon diel, seasonal and spatial distribution of phytoplankton and zooplankton. Primary production studies were a major part of this effort. Surveillance of other lakes was continued and data interpretation from previous years completed, especially upon Lake Huron. Since moving into the new building, considerable effort has been made upon isolation and culturing of phytoplankton and zooplankton for life history toxicological and other studies.

Surface Chlorophyll and Primary Production

In 1972, during the International Field Year for the Great Lakes, primary production was measured *in situ* in Lake Ontario on nine cruises at two fixed stations. The daily production was measured on short-time intervals over the whole day at various depths to 20 meters. Photosynthetic rates were compared with biomass present using chemical parameters and with measurements of solar irradiance and the attenuation in the water column of the part of the spectrum which can be utilized in photosynthesis. There was a strong difference between the inshore and the offshore stations in spring and early summer. The inshore station showed consistantly higher photosynthesis rates reaching a peak in June (1.9gC m^{-2} day^{-1}. From April to June at the offshore station the rates were constantly low (0.4gC m^{-2} day^{-1}), while in July and September the rates were high (1.4gC m^{-2} day^{-1}).

During the 48-hour investigation period on the two stations the daily radiation energy differed sometimes by a factor of 3, while at the same time the daily production rates per unit square meter varied by a factor of at most 1.7. At the offshore station the daily efficiency of algae (% of energy at 400-700nm fixed) varied by a factor of as much as 2.4 on two consecutive days and ranged from 0.2 – 0.17, and at the inshore station from 0.10 – 0.15. This means that in the euphotic zone (0-20m) 10 – 17% of the biomass present was renewed daily.

Chlorophyll and primary production measurements (^{14}C method) were analyzed in 1972 from 13 cruises on Lake Ontario and 10 on Lake Erie made in 1970 and additional cruises on Lake Huron in 1971.

In general, Lake Ontario chlorophyll *a* values were highest in inshore waters (<20m depth) and in the eastern portion of the lake. Lake Erie chlorophyll *a* levels were related to basin and season of sampling. In Lake Huron values were generally low except for Saginaw Bay where the highest mean chlorophyll *a* values were found for the three lakes (Fig. 42). Seasonal cycles of chlorophyll *a* varied in the three lakes, but the bimodal pattern was most prevalent.

Primary production was directly correlated with chlorophyll *a*. Highest values of production occurred in Saginaw Bay and the Western Basin of Lake Erie, with lowest values in eastern Lake Erie and Lake Ontario (Fig. 43). Assimilation ratios, mgC/mg chlorophyll *a*/hour, were generally related to nutrient distribution in the three lakes.

Monitor cruise data for chlorophyll *a* in Lake Superior collected in 1970 and 1971 were compiled (Fig. 44). Values were extremely low, roughly half of those found in Lake Huron, which indicates that Lake Superior is an extremely oligotrophic environment. No definite trends were found in the pattern of chlorophyll in Lake Superior. Inshore areas did not appear higher than offshore regions as in the other lakes, indicating that no pronounced effects of nutrient inputs occur along the shore.

Phytoplankton

Integrated phytoplankton samples (0–10m) had been collected from Lake Huron in 1971 on eight monitoring

cruises between mid-April and early December at 48 stations distributed over the entire lake. A preliminary analysis of two inshore stations and one mid-lake station indicated that diatoms and flagellates (Chrysomonadinae, Cryptomonadinae and Dinophycinae) contributed significantly to the phytoplankton biomass. The abundance of flagellates was striking and its species composition was more or less similar to that found earlier in Lake Ontario and Erie. The spring maximum in Lake Huron was dominated by diatoms and flagellates. During the summer season the phytoplankton was composed mainly of greens, blue-greens and flagellates, whereas blue-greens, flagellates and diatoms occurred in the fall. The inshore station in Saginaw Bay showed the maximum phytoplankton biomass.

The lakewide study dealing with the seasonal abundance and composition of Lake Erie phytoplankton communities was completed. A mean spring value of 6.7 x 10^6 μ^3/ml was observed in the Western Basin which was higher than in the other two basins. The monitor station off Colchester in the Western Basin showed the highest total biomass value of 21.0 x 10^6 μ^3/ml. On a yearly basis the Eastern Basin had the lowest levels of phytoplankton biomass. A ratio of 1 : 1.4 : 2 was calculated for the Eastern, Central and Western Basins respectively. Diatoms were dominant, followed in importance by flagellates which were abundant in the Central and Eastern Basins. Microflagellates contributed up to 60% of the total phytoplankton biomass. The significance of microflagellates has been neglected in the past but this study demonstrated their importance. Seasonal abundance of total phytoplankton biomass and the contributions of various taxonomic groups in central Lake Erie were examined (Fig. 45). Four maxima were observed, one in spring, two in summer and one during the fall.

Zooplankton of Lakes Huron, Erie and Ontario

The numbers of crustacean zooplankton were compared from cruises at 30 stations on Lake Erie in 1970 and 12 stations on Lake Huron in 1971. Differences were

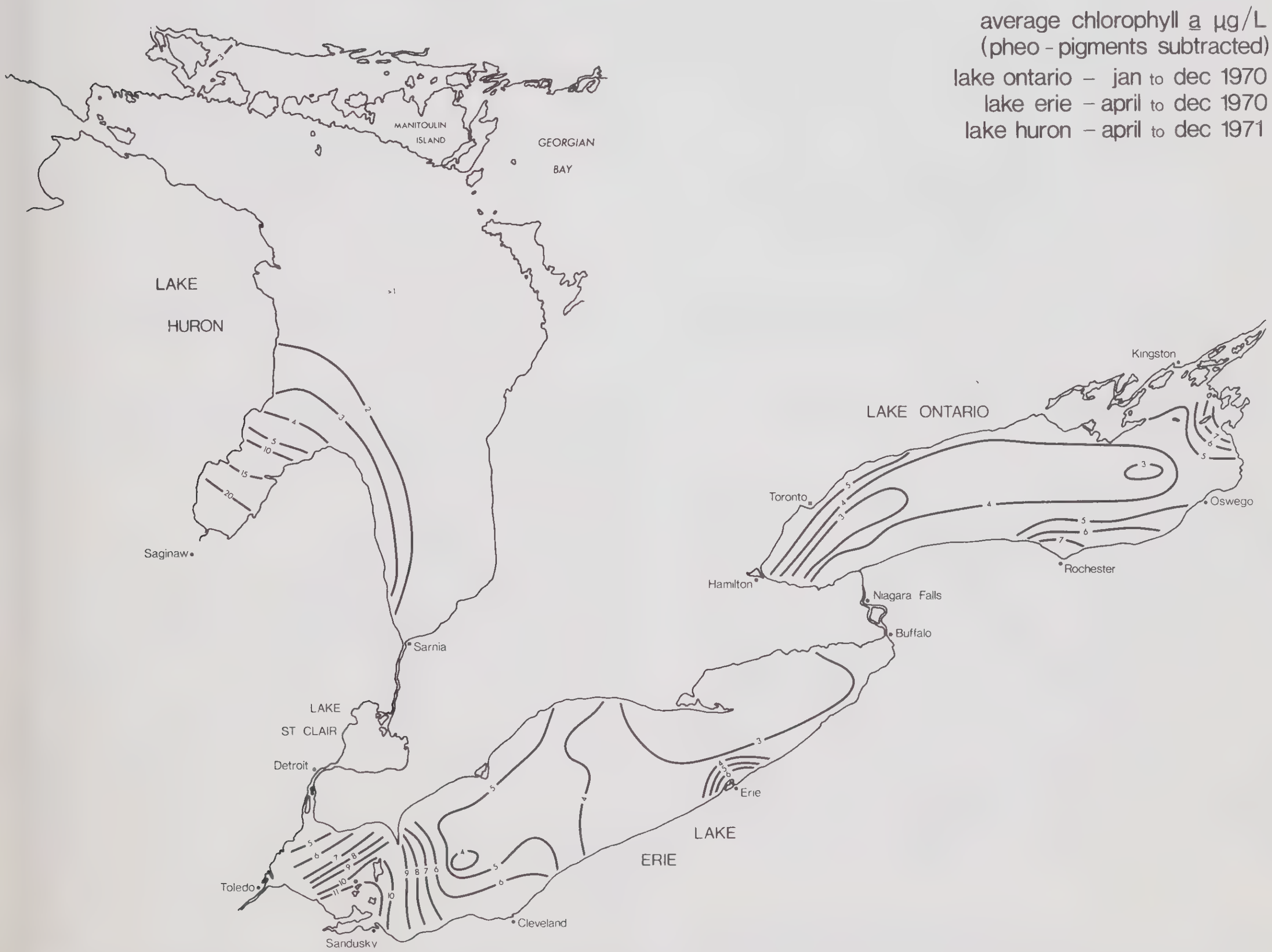


Figure 42. Average chlorophyll a, μg/l, in Lake Ontario (January to December, 1970), Lake Erie (April to December, 1970), and Lake Huron (April to December, 1971).

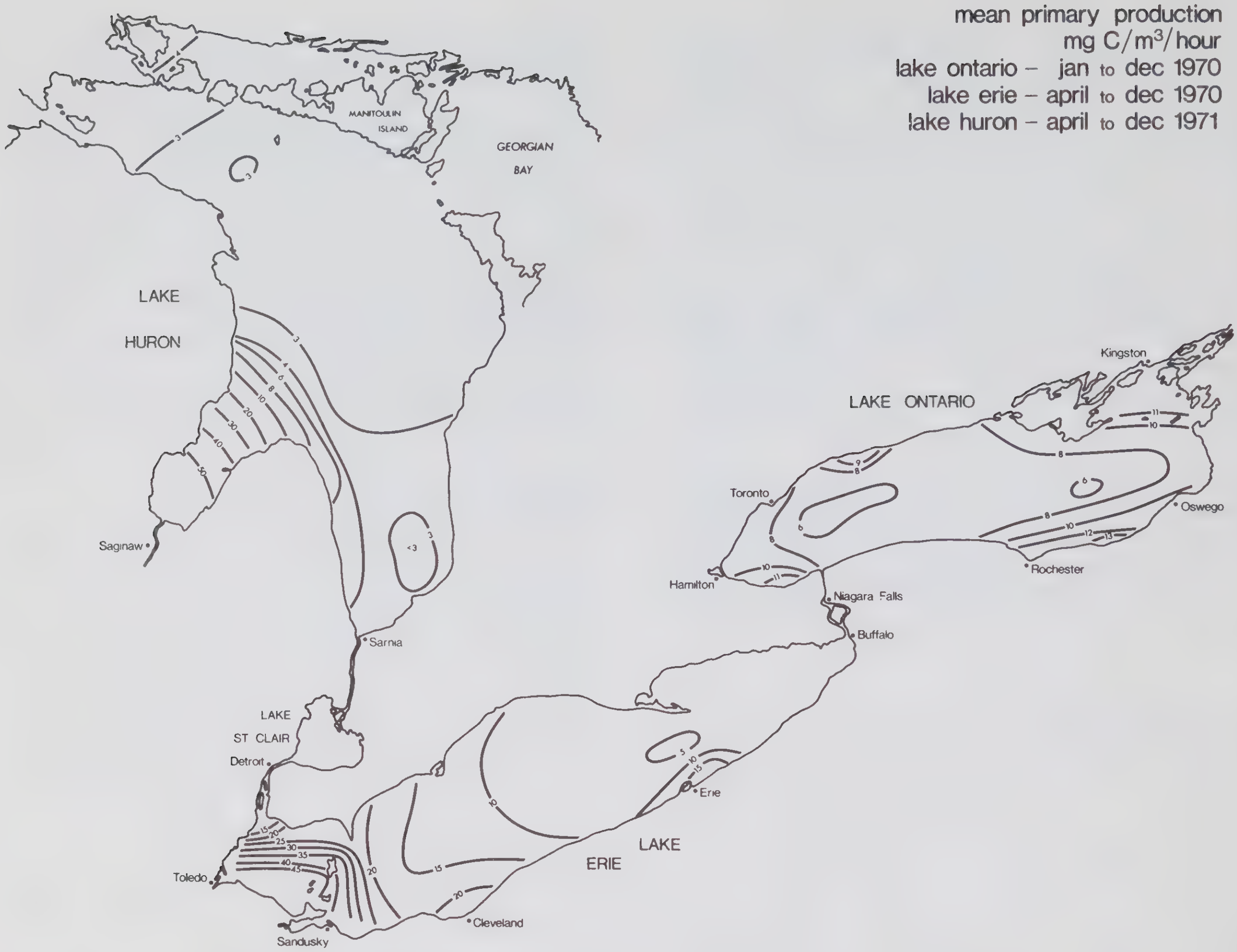


Figure 43. Mean primary production, mgC/m^3 /hour in Lake Ontario (January to December, 1970), Lake Erie (April to December, 1970), and Lake Huron (April to December, 1971).

recorded in the abundance and species composition of plankton with season in each lake and between lakes.

The species of zooplankton Crustacea are similar among lakes although the time of seasonal maxima and relative abundance is different for each (Fig. 46). Calanoid copepods are more numerous and diverse in Lake Huron and western Lake Erie. Cyclopoids and Cladocera are most abundant in Lake Erie and Ontario and in the Saginaw Bay region. The most prevalent species over the whole year in all three lakes is *Cyclops bicuspidatus thomasi* which becomes most numerous in Lake Erie. *Tropocyclops* is relatively important in Lake Ontario and *Acanthocyclops* in Lake Erie. Among the Cladocera, Daphniids are most numerous in Lake Erie, including *Daphnia, Bosmina, Diaphanosoma, Chydorus* and *Leptodora. Bosmina* is most numerous in Lake Ontario. *Holopedium* is most important in Lake Huron.

First order estimates of standing crop biomass have been calculated from estimates of zooplankton abundance in the three lakes. Populations of the relatively large calanoids present in Lake Huron produce biomass values which are relatively underestimated by numbers while in Lakes Erie and Ontario numerical values overestimate biomass.

Effect of PCBs on Phytoplankton

Recent studies have shown that PCB (polychlorinated biphenyl) compounds inhibit the growth and photosynthesis of marine phytoplankton at concentrations in the low ppb range. At CCIW *Synedra acus* and *Scenedesmus quadricauda* were isolated into pure culture and grown at 15C at a light intensity of approximately 10 klux. Additions of the commonly used PCB compound Arochlor 1242 dissolved in methanol were made to obtain concentrations of 1, 5, 10, 20 and 50 ppb in culture flasks. In *Scenedesmus*, inhibition of cell division was observed at all concentrations as early as 1 day after application. However, after 9 days, cell division rates approximated those in control cultures of Arochlor 1242 levels up to 10 ppb. At 20 and 50 ppb, cell numbers after 5 days were approximately 20% of those in controls and did not recover. Cultures of *Synedra* showed similar effects. However,

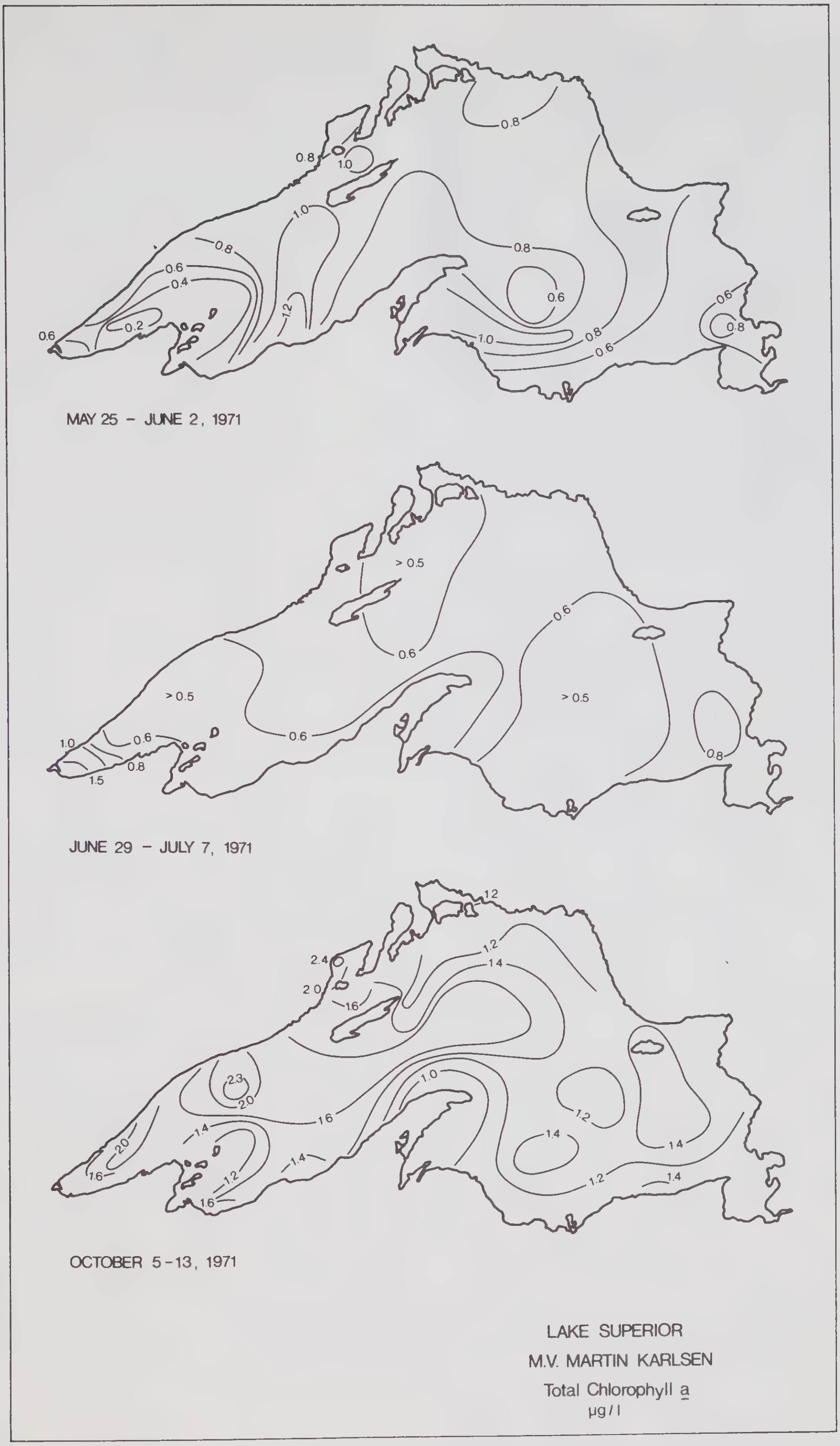


Figure 44. Chlorophyll *a* distribution in Lake Superior, 1971.

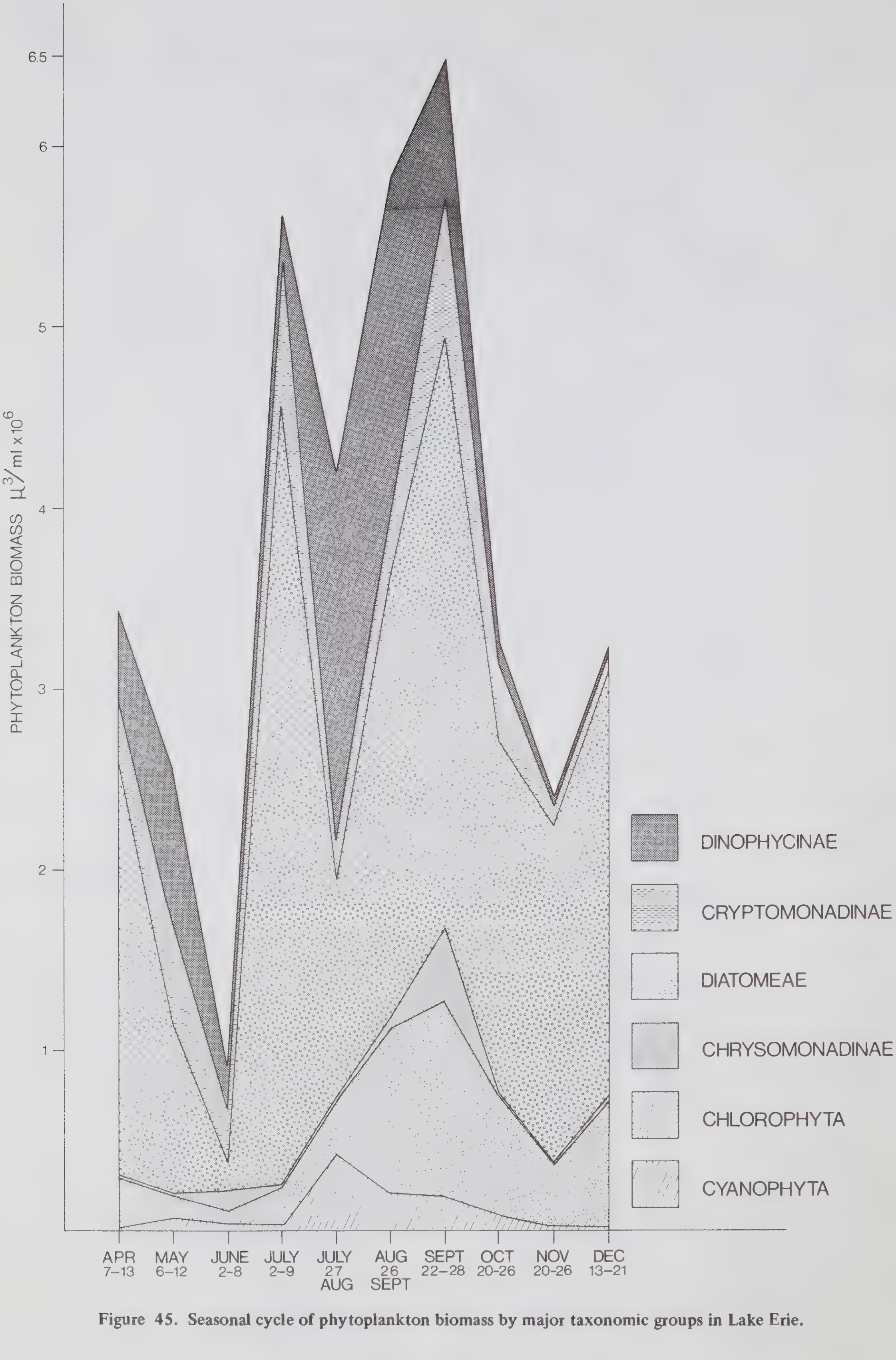
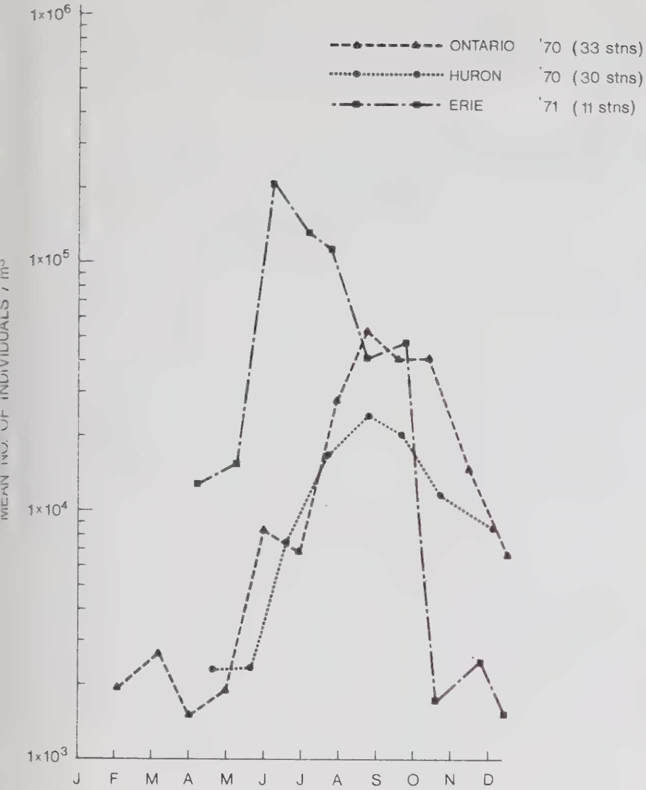


Figure 45. Seasonal cycle of phytoplankton biomass by major taxonomic groups in Lake Erie.



'igure 46. Comparative zooplankton numbers, individuals/m^3, in Lakes Ontario, Erie and Huron.

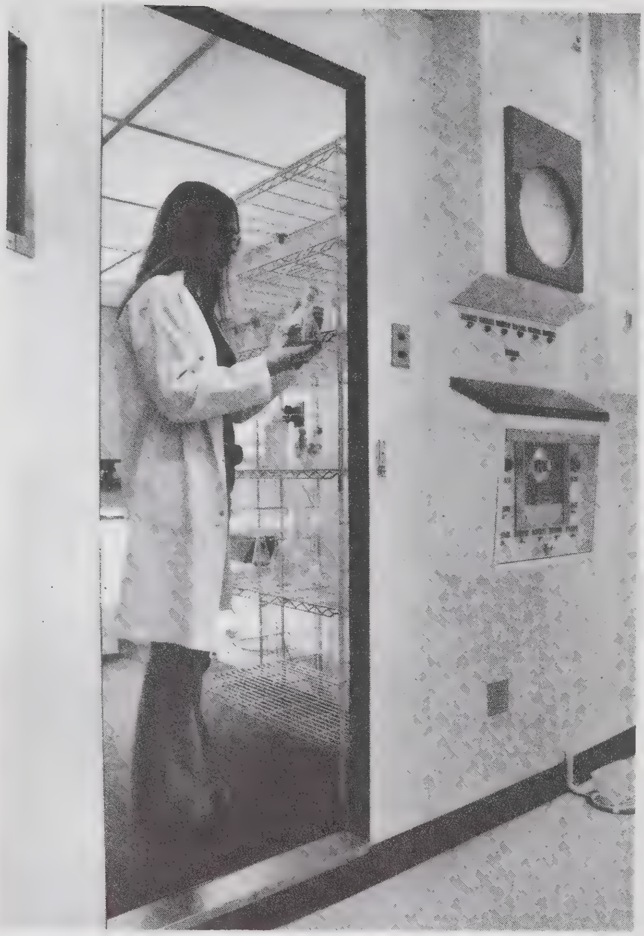


Figure 47. Controlled environment room for culturing of algae and invertebrates for research programmes in toxicology and physiological research.

ɔeyond day 7 all concentrations inhibited cell division over :ontrols by 35% at least, while 50 ppb reduced cell ıumbers by 75%. The reduction of cell division rates in ɔoth species may have been related to inhibition of ɔhotosynthesis observed in carbon −14 uptake studies. Chloroplast morphology was altered at all PCB concentra-ions.

\utomated Particle Counting System

Two electronic particle counters: The Millipore Corpn. 'π MC" Particle Measurement Computer System, and the Coulter Counter Model "B" were compared with the nverted microscope technique in counting and sizing a ariety of algal species in culture, as well as Lake Ontario hytoplankton samples. There was generally good correla-ion between electronic and microscope counts of uni-ellular species, but the reverse was the case for field amples of phytoplankton. Quantitative measurements of hytoplankton were erratic, if not erroneous, and of uestionable value. Evidence strongly suggests that the lectronic instruments are best suited to specific investi-ations, especially those concerning area or volume de-erminations.

'lysis relicta Studies

The study of *Mysis relicta* was extended for a second ear to gain information on the life history of this species. ɔn the basis of further sampling it is strongly felt that the earlier reporting of *Mysis* as a monocyclic population is incorrect. Data collected from Lakes Huron and Ontario strongly suggest that there are two major breeding periods per year. Breeding females appear throughout the year, with two definite breeding peaks occurring during the spring and fall periods. However, according to available data the heaviest breeding period occurs in the fall. The brood size remains relatively constant, with each breeding female carrying approximately twenty young.

Project Quinte

Primary production and phytoplankton communities were examined weekly at seven stations in the Bay of Quinte and zooplankton were collected monthly as part of a co-operative study among Ontario Ministry of the Environment, Ontario Ministry of Natural Resources, University of Guelph, Queen's University and Environment Canada. This study will lead into an assessment of the effects of phosphorus removal on the limnology of the Bay of Quinte, involving almost all ramifications of improvements expected in water quality.

Marine Sciences Directorate (Central Region)

CANADIAN HYDROGRAPHIC SERVICE

The objectives of the Hydrographic Division (Canadian Hydrographic Service) of Central Region, Marine Sciences Directorate, are the gathering, processing and compilation of bathymetric data and marine information on the navigable waters contained within the boundaries of the region, that are essential to the safe, orderly and efficient conduct of commercial, recreational and defence shipping together with the survey requirements associated with the management of water resources and the protection of the marine environment.

In support of the foregoing, a hydrographic development group investigated and developed hydrographic survey systems, techniques and methodology, the Tides and Water Levels Section provided hydrodynamic data, the Electronics Maintenance Section operated and maintained survey, navigation and communication systems, the Marine Information Centre and a Cartographic Unit. During 1972, additional responsibilities, related to IFYGL, included the management of a contract for the rental of a Decca Survey System and associated services as well as the calibration of the system and the production of lattices for special IFYGL plotting sheets.

In carrying out the prime responsibility of the Canadian Hydrographic Service, a great deal of data is gathered and made available for other purposes; some of these data are almost by-products of our primary program. The output is valuable to such functions as transport and communications, limnological studies, culture, recreation and economic development.

The 1972 Field Programme was carried out by 50 hydrographic surveyors, 8 electronics technicians, and some 130 ships' crew. During the season, use was made of 3 ships, 26 survey launches, and 23 major survey craft as well as one floating electro-mechanical workshop. Six office trailers and 13 boat trailers were used. Two helicopters and three fixed-wing aircraft were used periodically. The total helicopter flying time was 1342 hours and the total fixed wing flying time amounted to 277 hours. The shore-based survey operations also required the use of 18 motor vehicles.

The Field Projects were carried out in Nares Strait, Norwegian Bay, Jones Sound, and Amundsen Gulf in the Arctic; in James Bay and Hudson Bay; in Playgreen Lake in Northern Manitoba; in Lake of the Woods in Western Ontario; in Georgian Bay; in Lake Ontario, Lake Erie; St. Lawrence River between Montreal and Kingston as well as in the lower St. Lawrence River below Quebec. In addition to this program, a co-operative program was carried out with the Province of Quebec to obtain hydrographic data required for the development of a mathematical model of a section of the Richelieu River between the US border and St. John. In co-operation with the Ontario Government, a small program was carried out in south-eastern Georgian Bay to assist with pollution studies. This field program involved the use of electronic positioning and distance-measuring systems in addition to the usual optical systems and included the use of tellurometers, hydrodist, Mini-fix, Decca 6f survey system, RPS, automatic data acquisition systems and automatic data processing systems as well as a number of tide gauges, water level gauges, and current meters.

As an on-going program to develop systems and techniques which will allow maximum return from our investment in human and material resources the Development Group continued research into the use of electronic positioning systems particularly Loran C and the use of a variety of side-looking sonars and, as a new program, monitored the first full hydrographic survey to be contracted to a commercial firm. This program was carried out in Georgian Bay.

The resurvey of Navigation Ranges Program which was commenced in 1969 was continued in 1972 and by the end of the field season a total of 99 navigation ranges and associated channels in the area between Quebec and Kingston had been resurveyed. Also in this area a total of 48 fixed navigation lights had been re-positioned. A large number of ranges and fixed lights have also been resurveyed as a normal part of other hydrographic projects. However, some 82 ranges and associated channels as well as 342 fixed lights remain to be resurveyed in the Great Lakes.

The systematic Revisory Survey required to maintain existing charts up-to-date was continued and all charts of Lake Erie and Lake Ontario were field examined during 1972. Data for the Shore Properties was collected as part of the ongoing survey project.

During the year the Tides and Water Levels Section was strengthened in preparation for 1973 Field Programmes. In addition to its normal functions related to navigational matters the Section undertook the co-ordination of an Oceanographic Program in James Bay which was carried out

by the Hydrographic Survey team operating from CCGS NARWHAL in co-operation with the Atlantic Oceanographic Laboratory.

1972 saw the initiation of a technical exchange program with the Lakes Survey Center of the US National Oceanic and Atmospheric Administration of Detroit. Mr. Peter Richards of Central Region's Canadian Hydrographic Service component was exchanged for a three-month period with Mr. W. Bergen of NOAA. This exchange demonstrated beyond a doubt the value of such a program and we look forward to a continuation of exchanges. Meetings were also held between the Canadian Hydrographic Service, the Director of Central Region and the Director of the US Lake Survey Centre at Detroit with regard to future co-operative program and a decision was reached to attempt a co-operative Revisory Survey Program on the St. Lawrence River during 1973.

Also on the International scene a joint Canadian-Danish team worked in the Nares Strait area and determined geographic co-ordinates for Hans Island. This joint program was carried out because of the close proximity of the island to the limits of Canadian and Danish territorial seas.

Hydrographic participation in the limnogeological programs of the Centre continued, with provision of survey and survey system expertise to man the systems and to check for positioning and depth record quality.

The 1972 season was carried out without serious accident and all objectives were achieved.

IFYGL AND LIMNOGEOLOGY PROJECTS

Perhaps the major project undertaken by the Marine Sciences Directorate, as an integral part of the Canada Centre for Inland Waters, during 1972 was participation in the International Field Year for the Great Lakes (IFYGL) study of Lake Ontario and Basin.

The primary objective of the IFYGL program which will continue into 1973 is to develop a sound scientific basis for water resource management on the Great Lakes as an aid in solving problems of water quality and quantity. Lake Ontario and the Ontario Basin were selected as representative of physical characteristics typical of the Great Lakes and other fresh water bodies throughout the world.

Specifically, personnel from the Canadian Hydrographic Service, Central Region, have to date effectively carried out a comprehensive phasing-in and calibration/evaluation exercise of the DECCA (6f) positioning system — navigation on the lake and over its basin being one of the more important responsibilities of the Directorate. This programme was headed up by F. L. De Grasse, under the direction of Mr. T.D.W. McCulloch, Director.

Decca Lambda 6f, Red Slave, Grimsby

In addition to being accountable for logistics, i.e. land rental, frequency licensing, etc. for the positioning system, a major bathymetric survey of the offshore areas beyond the 30 meter contour has been completed which will result in the publication of a new or revised edition of a bathymetric chart — our first contribution towards metrication in the Great Lakes utilizing the automated Hydrographic Acquisition And Processing System (HAAPS) aboard the research vessel 'LIMNOS'

Limnogeology Project Lake Erie

This is a continuing nearshore survey in which C.H.S. has participated for the past two summer field seasons. For this particular exercise our involvement consisted of a navigational survey system to provide high accuracy positioning and expertise to check positioning and depth record quality. Positioning and depth data are to C.H.S. standards and are used not only by the Limnogeological Project but also by ourselves for charting purposes. Mr. P. Davies, sub-party chief, assisted (part-time) by one hydrographer and one crew, was in charge of field operations.

Two similar short term limnogeology surveys were

Research Vessel LIMNOS

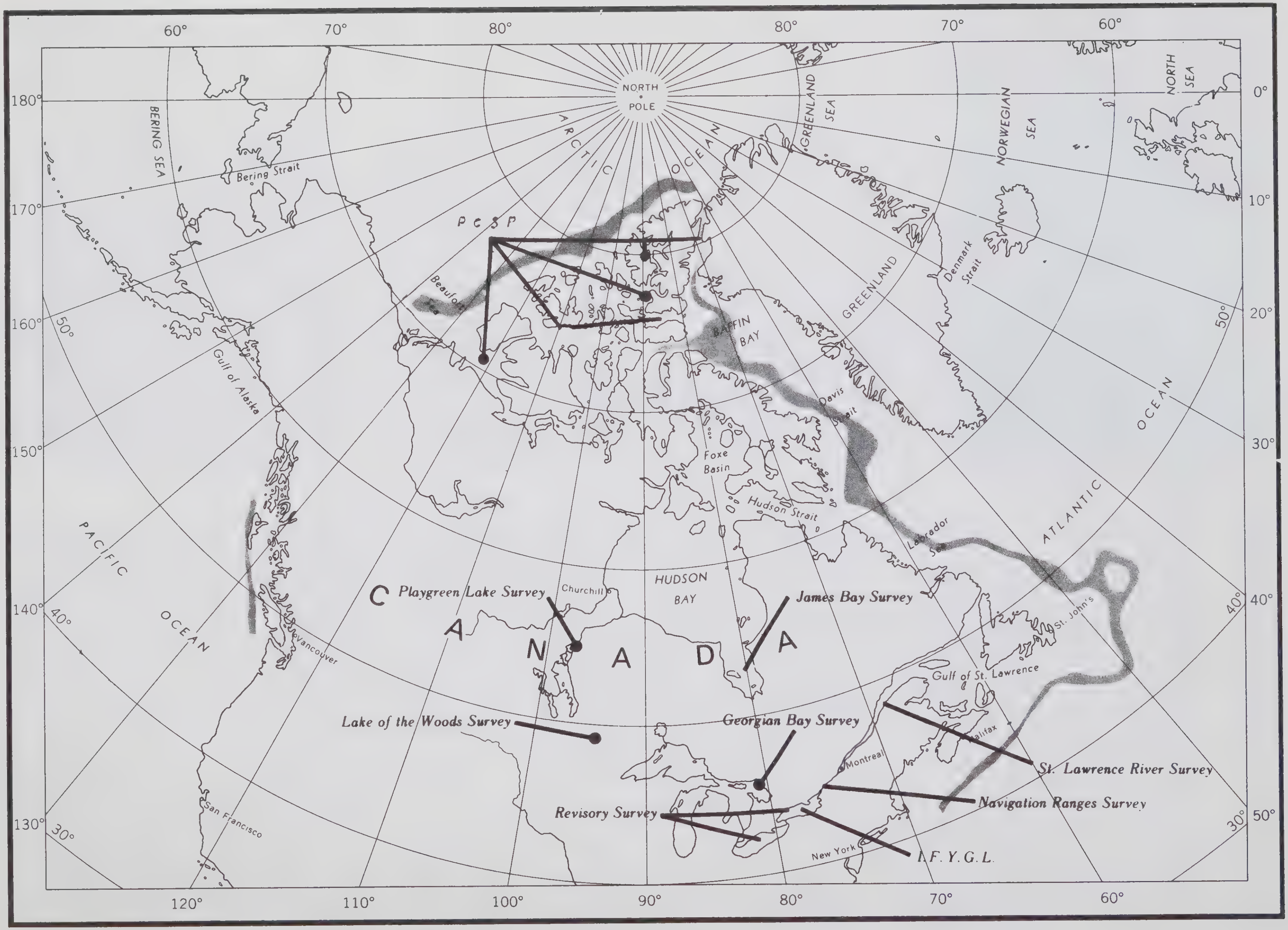


Figure 48. 1972 Surveys.

carried out to completion off the Burlington-Centennial Park area, western Lake Ontario.

In response to a request originated by headquarters of the International Boundary Commission, a marker buoy designated 'Y' was moored and positioned on the Canada-United States boundary approximately 13.5 nautical miles from Southeast Shoal Lighthouse at Point Peter on Lake Erie. Hydrodist MRB-201 and Wild T2 theodolites in the range-bearing mode were used for this exercise. The 9th Division of the U.S. Coast Guard is the agency responsible for aids to navigation in the area.

The MV MARTIN KARLSEN, a major vessel working out of CCIW was assigned to the establishment for this exercise.

To facilitate acceptance trials of the recently completed research vessel CSS ADVENT, two spar-type buoys were moored just south of the Burlington Canal to approximate a range distance of one nautical mile. The markers were subsequently fixed by Hydrodist and Wild T2 theodolites and the exact distance and bearing obtained by Inverse Solution.

JAMES BAY SURVEY

Jutting south from Hudson Bay is the relatively unknown body of water, James Bay. Equal in water area to Lakes Ontario and Erie combined, a basin for waters gushing seaward from many rivers draining the Canadian Shield, it has long been a bane to both explorer and hydrographer. Its rich but brief history extends from 1610 when Henry Hudson made his ill-fated plunge into these waters. The bay was named after Thomas James who, in 1631, sailed his ship, the HENRIETTA MARIA, deep into the bay, and after a scurvy-ridden winter hold-over at Charlton Island, escaped the following year for England.

Hydrographic interest in the bay has been sporadic at best. Limited navigation demands in the bay precluded extensive charting, and thus, except for a few harbour surveys and some charting of the extreme southern end of the bay, the major waters lay fallow of bathymetry.

The James Bay Development Corporation, and more specifically, the proposed hydro-electric projects, brought the area into sharp focus from a development point of view. Projects of a magnitude contemplated on La Grande Rivière required supplies on a scale that could only be supplied through commercial navigation. Thus, it was necessary to provide safe access routes for freighters and oil tankers traversing from Hudson Bay into the staging area at Fort George. At this time, 1971, Central Region, with an expertise for big term projects on short notice, became the dominant character in this narrative. In December 1971, it was decided to proceed with a control survey along the east coast of James Bay. This was a basic requirement in order to provide electrical centres for proposed positioning systems.

The 1972 work in James Bay was divided into three stages. The initial stage — the winter control program which ran from March 15, to April 30; secondly the shore survey, which was located at Fort George from June 15, to October 15; and finally the ship program, which employed the CCGS NARWHAL from August 7, until October 13 in the offshore survey area.

The results of the three surveys provided horizontal control extending seaward to all islands in the north half of the bay; standard hydrographic bathymetry on the approaches to Fort George, La Grande Rivière, an access corridor; reconnaissance surveys south to Eastmain and Paint Hills; and physical oceanographic data on a grid pattern in the northern half of the bay. A summary of each survey is as follows:

Winter Control Survey

The winter program embraced the efforts of five hydrographers, plus two helicopter crews. The hydrographers arrived in Fort George on May 20, and were followed closely by the two MSD Bell 206A helicopters. In

MOT Jetranger slinging a Millard tower to work site.

Millard Tower erected foreground shows old MOT radar reflector.

the following month control was extended from established geodetic points at Fort George, both north and south along the east coast of James Bay. In total, the traverse extended over 100 miles and closed on terminal geodetic points. The islands in the bay were controlled by trilateration, using Millard towers as necessary. Distances up to 60,000 metres were effected across the ice, in order to bridge and verify control to these islands. In addition, a number of solar observations were taken in order to confirm or establish azimuth values. Thirty-one permanent hydrographic positions were established during the survey, many on islands heretofore inaccessible.

The survey generated adequate control to satisfy Mini-fix and Hydrodist requirements on the summer surveys. Temperatures during the survey hovered between 0° and 30° Fahrenheit. Visibility conditions generally precluded observations beyond 6 miles. The helicopters logged 200 hours of flying, and provided an indispensible service.

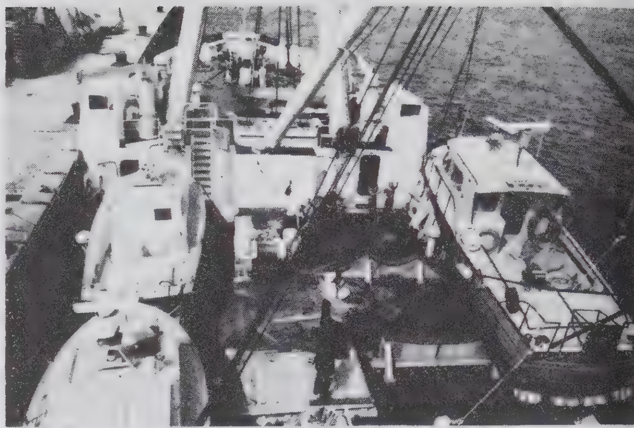
Shore Survey — Fort George

Once it became apparent that a large-scale survey would be required of the estuarine areas of La Grande Rivière, and of the three initial miles of the river itself, it was decided to operate a shore-based survey. In addition to the above tasks, the unit would be committed to the installation and maintenance of a water-level gauging program, the monitoring and maintenance of the Mini-fix system, plus the extension of local control to the numerous delta islands. Hydrodist was the system selected for positioning of the sounding platforms. Both the new MRB 201 and the vintage MRB 2 were used successfully. Two freighter canoes were obtained locally, and converted into sounding launches. Charting was conducted at a 1:10,000 scale over 100 square miles of coastal waters. A proposed harbour location, south of La Grande Rivière was charted as an alternate to the hastily erected discharge depot 3 miles up river. In general, all objectives set for the shore party were achieved. A Bell 206A helicopter permanently attached to the party, was in continuous use either supporting the sounding programs or the maintenance requirements. The continuous dust-bowl conditions of Fort George did not discourage the shore-based unit, and their four month siege in this settlement can be summed up as a profitable campaign.

Ship-Based Survey, CCGS NARWHAL

On July 26, the NARWHAL, a 250 ft. M.O.T. ice strengthened vessel primarily designed as an arctic personnel carrier, departed Quebec City, and sailed for James Bay. On August 7, after a quiet passage up the Labrador Sea, through Hudson Strait, and down Hudson Bay, the ship entered James Bay and commenced the designated charting and oceanographic programs.

The 10,000 mile cruise of the NARWHAL combined physical oceanography with contemporary hydrography. While the basic program involved charting using a horizontal control system, much reconnaissance work was



CCGS NARWHAL at Quebec City.

completed, including tracks into, and surveys of, the settlements of Paint Hills and Eastmain.

Salinity and temperature profiles, *in situ* water and temperature samples, dissolved oxygen analysis, plankton casts, bottom cores, and light penetration measurements were taken as part of the oceanographic program. 65 stations were occupied. The controlled charting program evolved within a 3000 square mile lobe extending seaward from Fort George. Three survey launches plus the ship were employed to establish bathymetry along a preselected corridor. In total, over 5000 miles of sounding was completed. A beefed-up Mini-fix system (50 watts possible output as opposed to a standard 16 watt output), with baselines in excess of 30 miles, was used to provide horizontal control for sea-borne platforms. In addition, a receiver was mounted into a helicopter.

The ship spent a total of 56 days in James Bay. The total cruise embraced 99 days. A bunkering trip to Churchill, Manitoba, an emergency fuel lift to Whale Cove on the west coast of Hudson Bay, and time consumed steaming to and from terminal agency points, consumed the remainder of the cruise.

The information obtained during this cruise established a viable route for commercial shipping, from Cape Louis XIV into an anchorage area at La Grande Rivière estuary. It also proved the feasibility of operating close to the east coast along north-south tracks. The hazardous, unpredictable, bottom topography was alarmingly evident on all operations, and required the full deployment of resources to insure a safe passage across previously unknown water. Much was accomplished. Much more remains if safe navigable channels are to be established.

POLAR CONTINENTAL SHELF PROJECT

The Hydrographic Section of Polar Continental Shelf Project departed for the 1972 survey operation on May 1st via Resolute Bay to Alert, N.W.T. to commence the first of four assignments.

Base camp, Alexandra Fiord.

Base camp, Surprise Fiord.

l. to r. M. Thamsborg, J. Ekholm (Danish representatives), M. Haycock (National Archives representative).

From the Alert base, a network of horizontal control was extended in the Nares Strait area from Robeson Channel southward to Franklin Island. The base of operations was then moved to the R.C.M.P. Camp at Alexandra Fiord, where the control system was completed to the northern end of Smith Sound. We were joined in this assignment by two Danish representatives whose efforts were much appreciated and who worked very hard to make the combined Canadian-Danish survey a success. Closure for the system was in the order of twenty parts per million over a distance of five hundred miles of traverse. A total of sixty monumented horizontal control stations was established, mainly on the Greenland coast.

Included in the assignment was the positioning of a small island, Hans Island, whose exact position was in some doubt. In the process of locating the island some discrepancies in the shoreline of Greenland were adjusted by as much as two and one half to six kilometers.

Second on the list was a brief sounding survey in Eureka Sound for the safe passage of ships bringing construction and drilling equipment in to sites located at Mokka Fiord and Depot Bay. A total of seventy through-the-ice soundings was required to cover the designated area.

From Eureka the establishment set up camp at Surprise Fiord where a second control survey was conducted covering the whole of Norwegian Bay. The purpose of this part of the field operation was the selection and location of suitable sites for an RPS controlled survey presently planned for the coming winter sounding program in March 1973. Most of the time was used in the recovery of existing control, which is, for the most part, suitable to our purposes. Only four new points were required to provide adequate coverage.

Last on the list of operations was the establishing of electrical centres for a Hi-Fix controlled survey in the Jones

Mechanical repairs to skidoo.

Sound area. A base of operations was established at Grise Fiord from which the required sites were obtained in four days. A total of twelve stations was required to give suitable coverage for this survey to be conducted by personnel from the Atlantic Oceanographic Laboratory.

On completion of the Jones Sound project the members (staff and support group) of the Hydrographic Section, P.C.S.P. returned to headquarters on July 7th where computations, field notes, etc. were submitted to Nautical Geodesy for checking and adjustment.

Throughout the operation no difficulties were encountered with electronic instrumentation. Elevations of traverse stations were checked by use of altimeter on the helicopter (a Bell 205A) and barometric observations. All control points established throughout the field season were targeted and photographed from the air using hand-held cameras (Polaroid and/or 35 mm)

In addition to the above, logistic support was provided to members of the Earth Physics Branch, Dept. of E.M.R. who were carrying out further investigations of the Alert "Magnetic Anomaly" about 75 miles offshore on Lincoln Sea. Support was also provided to an official who was conducting assignments for the National Archives, Department of National Defence and the R.C.M.P.

LOWER ST. LAWRENCE SURVEY

The 1972 hydrographic survey on the Lower St. Lawrence River was a continuation of the project begun in 1969; namely, the resurvey of the river from Pointe au Père to Quebec City, a distance of 133 miles.

Staff gauge crib at Goose Cape, Lower St. Lawrence Survey, 1972.

Work was concentrated, during 1972, in the areas east and southwest of Ile aux Coudres.

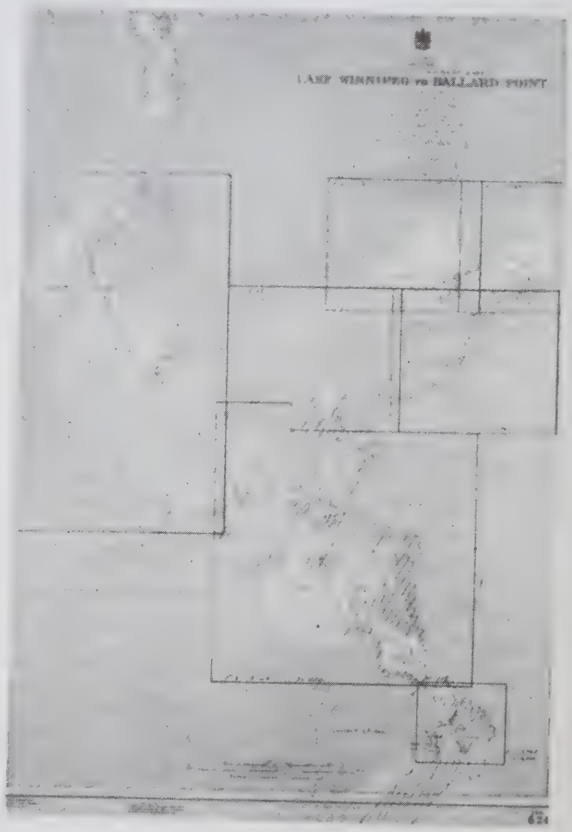
Soundings were taken in metres and all field sheets were inked in metric units.

Hydrodist and Motorola R.P.S. positioning systems were used to control 4 sounding launches.

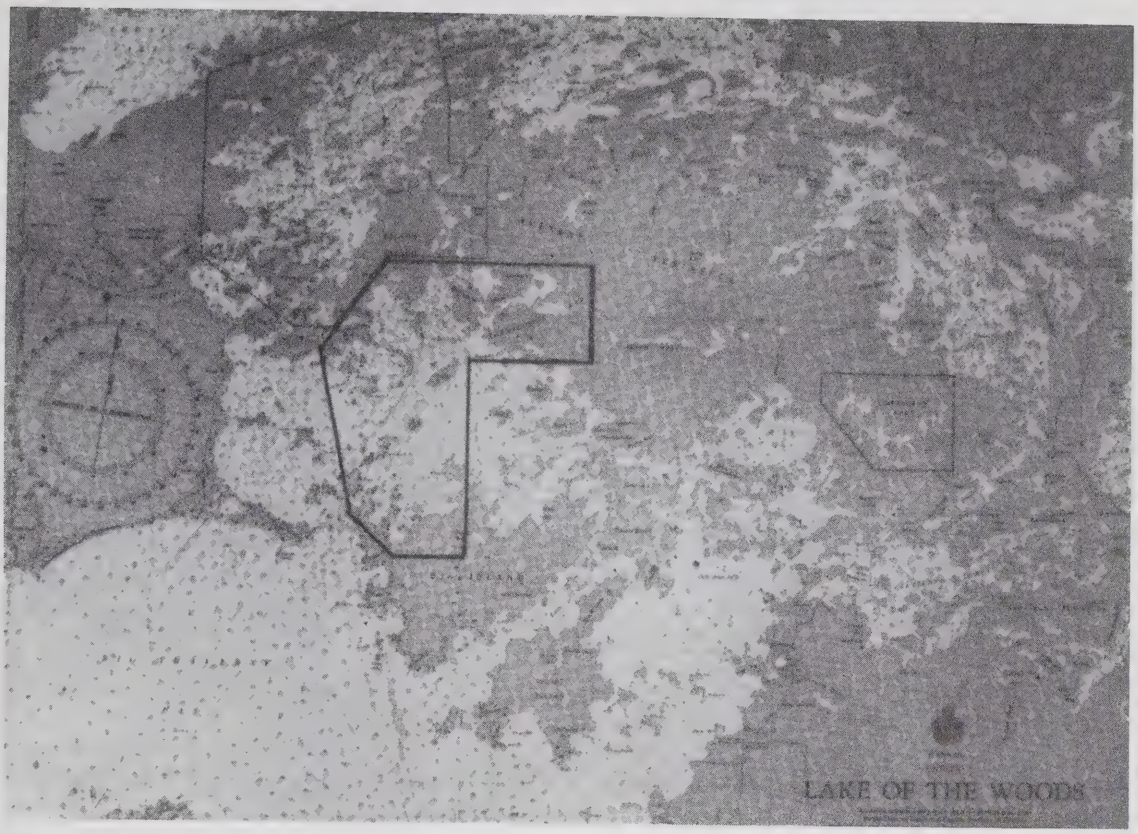
The main deep draft shipping channel has now been completely surveyed from Ile du Bic to Cape Maillard, a distance of 94 miles. Future operations upstream from Cape Maillard will depend on the completion of a large scale dredging programme presently being carried out southwest of Cape Brûlé.

PLAYGREEN LAKE SURVEY

This was a continuation of the 1971 hydrographic survey. The demand for a modern hydrographic survey came as a result of the Nelson River Power Project whereby diversion channels from Lake Winnipeg to Playgreen Lake and Playgreen Lake to Kiskattogisu Lake are to be built for the purpose of regulating the water level in Lake Winnipeg. Therefore, a requirement for modern hydrographic charts was created for monitoring siltation and its effects on navigation in the future.



Playgreen Lake Survey, 1972.



Lake of the Woods. Area completed in 1972.

The charting program was carried out from Warren anding by a party of ten staff and thirteen crew from May 4 to Sept. 28.

The new "21 ft. MON-ARK" launches carried out the ajor part of the sounding program. Hydrodist in the nge-bearing mode was used for positioning in open areas nd visual positioning in congested areas.

This survey went exceptionally well, considering the rbid, shallow and shoal infested waters, however, the area etween Sandy Bar Point and Whiskey Jack Landing emains to be done. The area completed this year extended om the outside entrance to Warren Landing to Sandy Bar oint on Playgreen Lake, both branches of the East Nelson iver and approximately 50% of Little Playgreen Lake.

LAKE OF THE WOODS SURVEY

For the sixth consecutive season, Central Region elded a hydrographic survey party in Lake of the Woods. ne party this year was divided into two sections with the ain group staying at a trailer camp in Morson, Ontario, hich it had occupied since 1970, while a sub-party, mprising 8 to 14 men operated out of commercial tourist mps in the 3770 field sheet work area.

The party undertook to survey Obabikon Lake (a large bay of Lake of the Woods located in the Aulneau Peninsula), and field sheets 3769 and 3770 on the western side of Lake of the Woods bordering on Minnesota, U.S.A. A revisory survey of field sheet 3653, between Miles Bay and Morson, was also completed.

Most of the sounding was done by three-man crews using 21 foot Botved launches and EDO 9040 echo sounders. The conventional sextant resection technique was used for position fixing.

In late September, launches and equipment were stored at Winnipeg and at the Hydrographic Depot in Selkirk in anticipation of proposed activities in Lake Winnipeg.

A small sub-party will be required in 1973 to complete some field sheets initiated in 1972. This will provide bathymetry across Lake of the Woods in total except for Shoal Lake which has been dropped from the original survey proposals.

Remaining Navigation Ranges work along the St. Lawrence Seaway can be handled by a revisory team.

Among some of the work remaining is the continuation of the control network in Ile Delaurier area and the

sounding of that range. Nicolet and Pointe-du-Lac sounding lines have yet to be run. Future work in this area will be required if there are any relocation projects for ranges and lights.

Lights through the tourist regions of the Thousand Islands were not positioned this season. It was felt that as a result of the shortened field season, the seaway lights and ranges should be of prime importance so our efforts were directed along those lines.

During the period, July 17 to July 29, the senior hydrographer and Mr. Gorski conducted a reconnaissance survey of the Richelieu River between St. Jean and U.S. border. The survey was conducted at the request of the Quebec Department of Natural Resources for the purposes of flood control on the river.

NAVIGATIONAL RANGES SURVEY

The 1972 Navigational Ranges Survey began May 1 with the establishment of the Base Camp in Cornwall, Ontario. While there, three (3) channel lights, three (3) sector lights, and one (1) range (Cornwall Island range) were positioned. No soundings were obtained. However, sounding marks were established and channel buoys positioned along the range lines and sector lines.

The Base Camp then moved to Morrisburg on May 29. Four (4) lights and three (3) sets of ranges were positioned in the area adjacent to Chrysler Park and Morrisburg. Two (2) lights and two (2) ranges were positioned in the area adjacent to Mariatown and two (2) sets of ranges were positioned in the Iroquois area.

"CADET" was inoperative throughout this period. As a result the sounding program had still not begun. However, as was done in Cornwall, sounding marks were established and the channel buoys along the range lines were positioned.

While in Morrisburg, Mr. Eidsforth travelled to the Montreal area to establish horizontal control required for the positioning of the Ile Delaurier range.

The survey party moved up river to Brockville on June 16. From here, ten (10) Channel lights in the Brockville Narrows were positioned. By this time, our sounding program had seriously fallen behind. It now became obvious that "CADET" would probably not be operational for the remainder of the season and no boats were available to replace her. It was decided to outfit one of our whalers for sounding and hopefully we would get enough good weather to enable us to sound the range lines. Luck was with us and our sounding program was up to date by August 11.

August 12 saw the party move to Kingston, Ontario where three (3) lights, a sector light and Irving point range were positioned and sounding lines completed by the 25th of August.

Mr. Eidsforth then returned to Montreal to complete the control work for the Ile Delaurier range. The senior hydrographer and one crew member began preparation for the return trip to Burlington for August 31.

CSL VEDETTE in Kingston Harbour.

Sounder check by cone.

As a result of this year's efforts, 28 channel lights and 0 sets of ranges were positioned and 14 sets of ranges were ɔunded. Solar Azimuths were taken at all ranges except :ornwall Island range and Ile Delaurier range. These two anges were checked using the Gyro theodolite.

REVISORY SURVEY

During 1972, 22 charts were revised on Lake Ontario nd Lake Erie. It was the first time a revisory survey had een conducted on Lake Erie; Lake Ontario charts had een revised in 1968. Shore Properties inventory strip maps ere updated in conjunction with the revisory survey.

In addition, reported dangers to navigation in Lake ntario near Whitby Harbour, and in Lake Erie near mherstburg, were examined.

HAMILTON HARBOUR SURVEY

Hamilton Harbour Survey began in early April and will ntinue until completed. The harbour is 90% complete, owever a considerable number of wharves have not been arted.

Due to the number of wharves to be sounded in amilton Harbour, and Toronto Harbour, consideration as given to the possibility of improving the stretchline ethod of sounding the wharf areas.

The most efficient method to date is the use of a btense-bar with predetermined sextant angle for distance f by sighting through a transit or sextant. With radio mmunication to con the boat onto line, continuous unding lines can be run in lieu of lead line soundings.

The Code-Lite is a sector light, showing a green light hen on one side and red when on the other side of center, th the green and red alternating flashing lights being seen hen on the center line.

With the subtense method, two men are usually quired to move the subtense bar and other equipment th two in the boat. Predetermined angles are required to tain the distance off and must be reset on the sextant hen approaching shore. Continuous voice communication th the boat must be maintained.

The Code-Lite can be mounted on a transit, with a ose system and a small 12 volt battery, attached to the s. One man can move this setup to previously established ints when surveying the wharf. A radio can be used if quired to supplement the control of the boat which can held on line by the coxswain.

A single sextant angle between the transit and one ntrol point, or between two base line control points ffices to position the boat off the wharf.

Besides the harbour, about 1/3 of the approach area to the canal has been sounded. It is planned to extend the coverage to overlap the Decca controlled sounding of the IFYGL programme carried out by the LIMNOS.

Code Lite Advantages and Disadvantages

Advantages:

1. eliminate one man ashore — by presetting the light two men in a boat can run lines — awkward when having to move the light, but possible.
2. reduces and/or eliminates voice control.
3. boat can get on line faster.
4. light being on a transit, fan lines can be turned off quickly.
5. transit can be used to do stadia work, if necessary.
6. light can be used to run lines across a river or fan lines in confined areas.

Disadvantages:

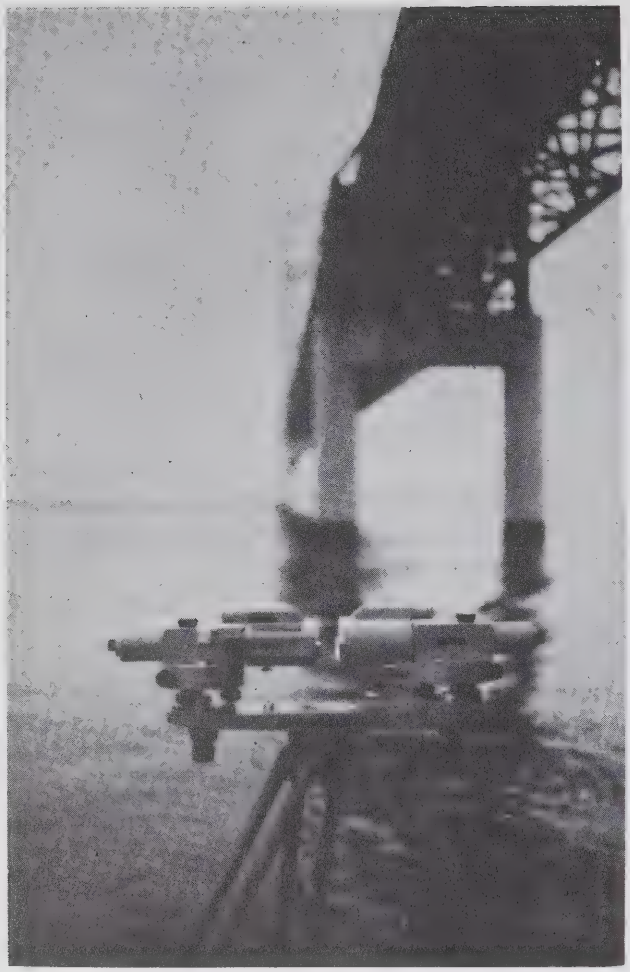
1. battery failure.
2. light breakdown.
3. plot may be required in boat, but not essential.

U.S. LAKE SURVEY CENTRE EXCHANGE PROGRAM

During the past field season, a four month staff exchange was undertaken between United States Lake Survey Centre and Central Region, Canadian Hydrographic Service.

The Canadian exchange consisted of a two week orientation period at the LSC Detroit offices followed by field work with the Vertical Control, Revisory, and Horizontal Control Sections for the remainder of the period. The work areas were along the shores of Lakes Superior, Huron and Ontario.

Zeiss level with micrometer attachment.



Zeiss water crossing equipment.

Office

The LSC comprises two main Divisions — Limnology (Research) and Marine Mapping and Charting. The area of responsibility for both is the Great Lakes and the Waterways as far west as Lake of the Woods. All the Sections were visited including the Compilation and Chart Production Branches.

Vertical Control Section

Field work consisted of running a precise level line and making a water crossing in the Straits of Mackinac area. Work included selection and placement of markers, use of 'KERN' rods and Zeiss level with micrometer attachment, and recording by computer. The water crossing involved special equipment and techniques.

Revisory Section

Lakes Superior and Huron were covered as part of a recurring three year schedule for the Great Lakes. The unit is a mobile land-based operation with an office trailer. A 54' revisory craft is used for chart work. A traverse of the Duluth-Superior Harbour area was done as well during th summer.

Horizontal Control Section

The field project was a first order traverse along th northwestern shore of New York State. Work include reconnaissance through to instrumental observations wi Wild T-3's and a laser Geodimeter. Data will be used b other agencies as well as by LSC for future hydrograph control.

HYDROGRAPHIC DEVELOPMENT GROUP

During 1972, many diverse and interesting projec were undertaken by this Group with good progress bei made in such important areas as automated data processin automated data collection, evaluation of positioni systems, sonar development and an evaluation of priva industries' capabilities in conducting hydrographic survey

Contract Hydrographic Survey

In June 1972, the Canadian Hydrographic Servic Central Region, awarded a contract valued at $89,500 Computing Devices of Canada to complete field wo necessary for the production of new charts for small boa and deep-draft ships in north-western Georgian Bay. Th location of the 60-square mile area from Cape Smith c Manitoulin Island to Killarney Harbour, is as shown c Figure 1.

This area is representative of many areas of Canada, the limits include open, relatively deep unrestricted areas well as narrow shoal-infested channels.

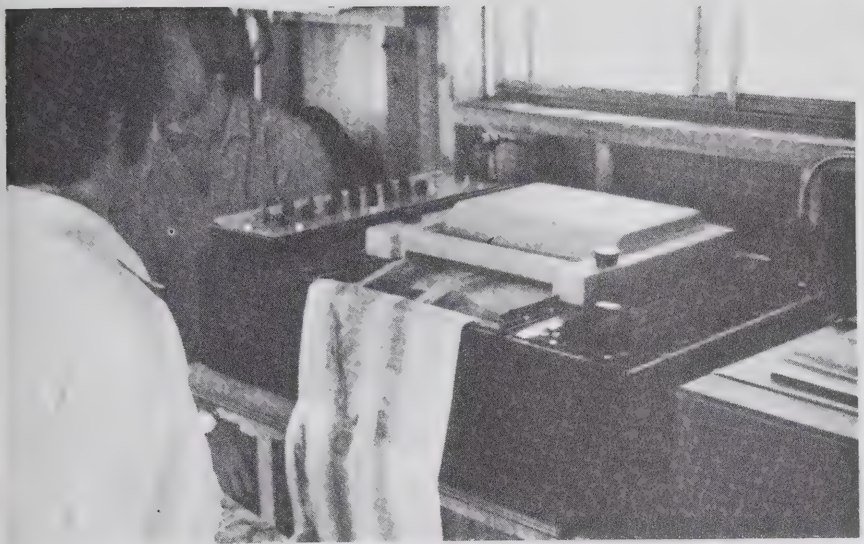
The survey contract was the first to be let by th Canadian Hydrographic Service following a recommend tion by the Science Council of Canada that, whe possible, government and university laboratories contra work to develop technical expertise in industry. It coincidental that the area chosen for this first contract in the same area as the first survey undertaken by t Canadian Hydrographic Service in 1883.

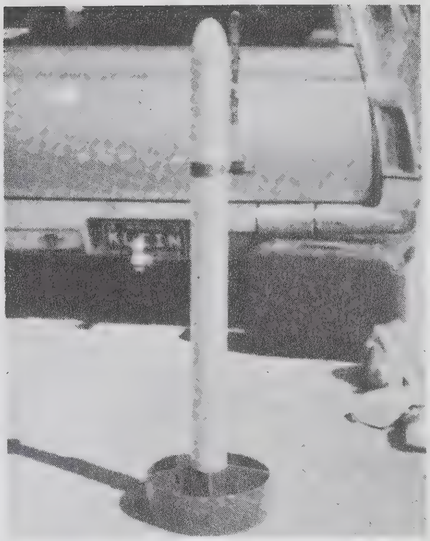
The Development Group responsibilities for the surv included the preparation of detailed survey specificatio review of the submitted tenders, and during the fie operations to ensure that accuracy standards and attenti to details as outlined in the specifications were bei adhered to. As this was the first contract surve responsibilities also included the development of effecti monitoring systems for future surveys of this nature.

A detailed report on this survey is available fro Central Region.

Sonar Development

As part of the Development Group's field program th year, considerable effort was directed toward the evaluati of side scan and omni-directional scanning sonar w potential for launch use on hydrographic surveys.





Klein Mk. 400 recorder and transducer units.

Four sonars, EG&G, MK 1A, KLEIN MK400, C-TECH LSS-30 and C-TECH LSS-30 (PT) were used during the program which was cunducted in the Killarney area of Georgian Bay.

All sonars were installed, at various times, on the modified barge "SORA" and an area of approximately 1.5 square miles was traversed with closely spaced and overlapping lines. A modern survey at a scale of 1:12,000 was available for this area, and numerous additional standard sounding lines were run in order to prepare an accurate contoured plot of the area. All shoal indications as detected by the sonar records were examined by conventional methods in order to fully develop the shoal contours.

The analysis of bottom coverage, comparison of sonars, descriptions of the equipment, the evaluation procedures and potential application techniques will be described in a paper to be presented at the 1973 Hydrographic Conference and copies will be available at that time.

EG&G transducer unit.

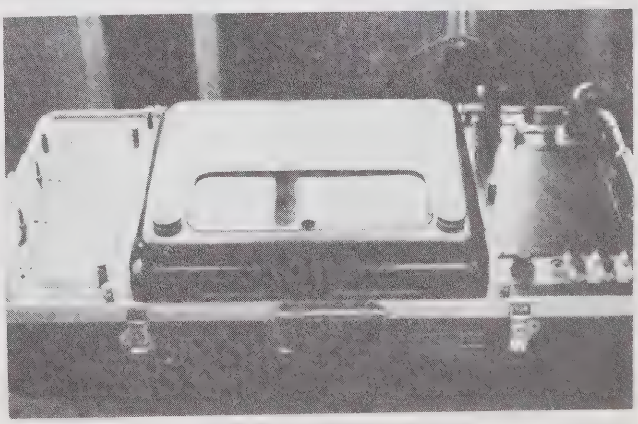
HAAPS Systems

Central Region presently owns the following equipment associated with HAAPS:

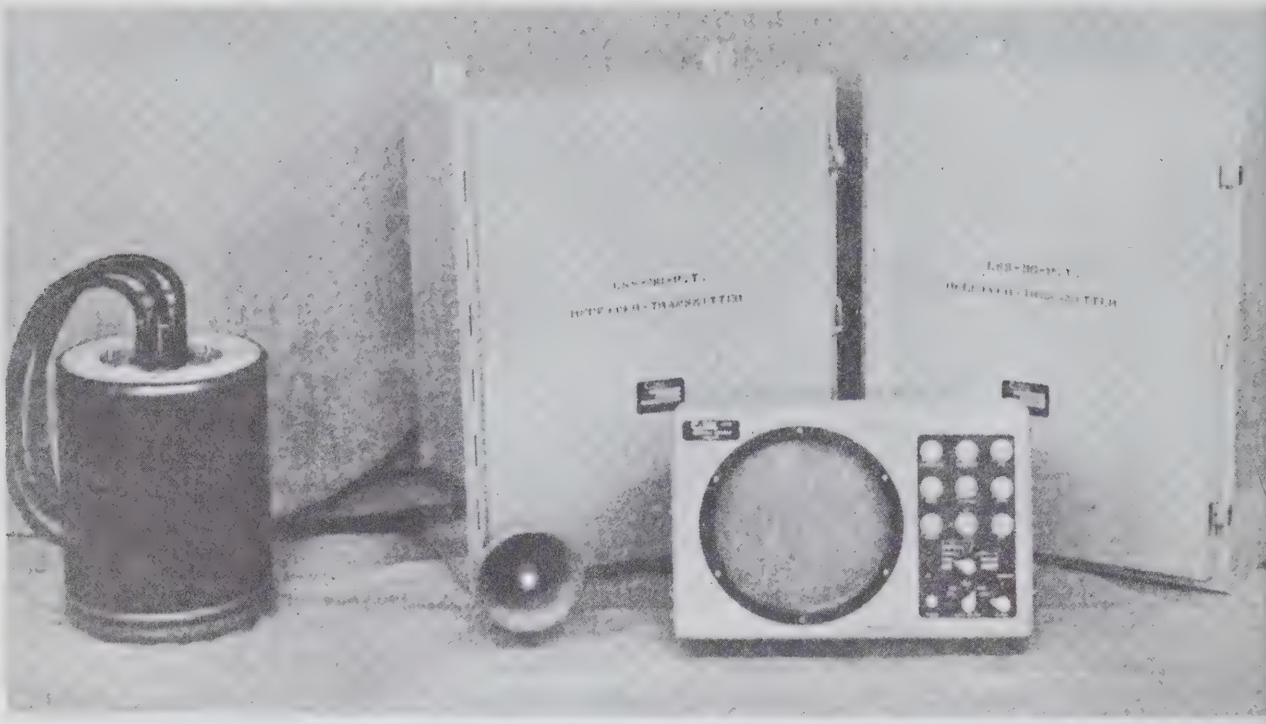
- 2 — C-Tech Depth Digitizers
- 2 — Digital Couplers
- 2 — Tape Recorders
- 1 — Atlas Depth Digitizer
- 1 — Decca Digital Display Unit
- 1 — PDP-8/E Computer with Peripherals
- 1 — Calcomp Plotter

During the year, two HAAPS acquisition systems were deployed in the field along with the one processing system.

The acquisition system using the Decca Digital Display Unit and Atlas Depth Digitizer was used exclusively on LIMNOS for the bathymetric Survey of Lake Ontario.



EG&G recorder unit.



C-TECH LSS-30 PT transducer, transmitter and display units.

Early in the year the equipment was installed in "VERITY" and used on western Lake Ontario to ensure that all systems were operational and that staff were adequately trained prior to the installation on LIMNOS.

The system was used for the entire Lake Ontario Survey with excellent results being achieved.

The second HAAPS system was deployed on a survey of approximately 45 square miles in northwestern Georgian Bay. (The area surveyed is shown in Figure 48).

Loran C Evaluation

As a possible positioning aid for survey and research vessels operating in the Upper Great Lakes a detailed evaluation of Loran C, in both Hyperbolic and RHO-RHO mode, was undertaken this year.

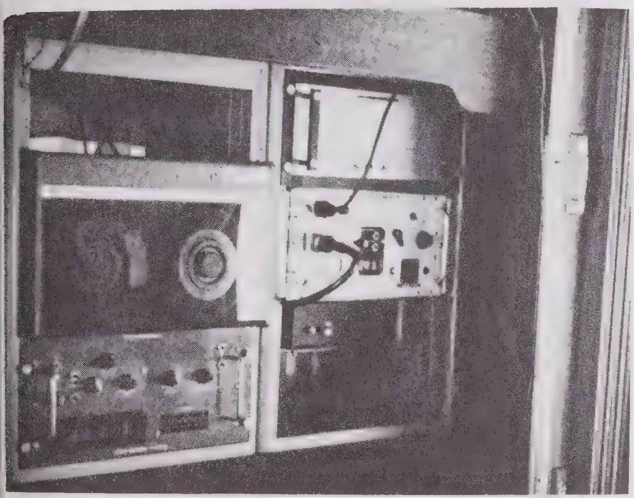
To assist in this study a DECCA ADL-21 receiving system, complete with Hewlet Packard calculator and plotter, was obtained on loan from the U.S. Coast Guard. In addition, an Internar 101 receiver was rented from HPL Engineering and the AUSTRON RHO-RHO system was borrowed from the Navigation Group at Bedford Institute.

The Decca ADL-21 receiver was used essentially as a monitor unit during the period that the Internar 101 was operated in the Northwestern area of Georgian Bay. This

HAAPS – Hydrographic Acquisition System as installed on LIMNOS.

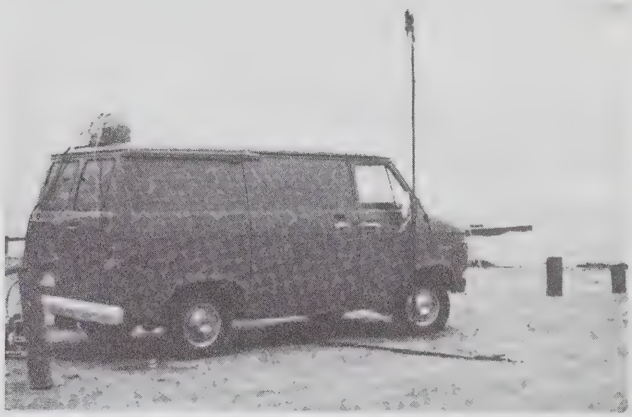
HAAPS – Processing System as installed on LIMNOS.

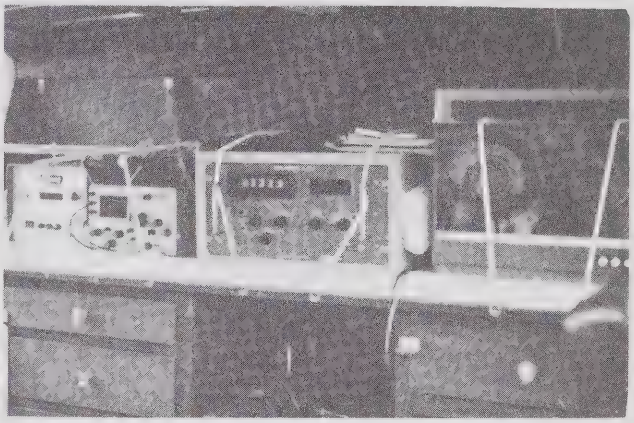
VERITY – used for HAAPS survey in Georgian Bay.



Equipment installation in VERITY.

Decca ADL-21 receiving and plotting system.





Electronics van with Loran C equipment installation.

phase of the trials involved the continuous logging (on magnetic tape) of both Loran C and Mini-fix signals for a comparison of accuracies.

For the second phase of`the Loran C evaluation, the Internar receiver along with magnetic tape logging equipment was installed in our Electronics van and recordings were made at known points along the shore of Lake Superior and Lake Huron. Recordings of 48 hours duration were made at five stations along Lake Superior and two stations along Lake Huron.

The next phase of the evaluation involved the use of the RHO-RHO system which again was installed in the Electronics van. Recordings with this installation were made at known points along the four Canadian Great Lakes and Georgian Bay.

The Loran C evaluation will be discussed in detail in a paper to be presented at the next Canadian Institute of Surveying annual meeting.

Harbour & River Positioning System

The need for a more efficient method of positioning survey vessels in confined areas such as harbours and rivers has long been apparent. To assist in this area the Region

purchased a CODE-LITE, which emits a visible fan-shaped beam using high intensity Xenon lamps. The beam is made up of three sectors with each beam encoded for visual identification. The central beam can be adjusted from approximately 20 seconds to one minute of arc which makes it ideal for running ranges on short-range work.

To further assist in positioning vessels within short range, an acoustic measurement system is being developed from existing digital echo sounders. Preliminary tests of this system in 1972 have been successful in providing encouragement for continued effort in 1973.

Data Processing & Development

Much of the data processing activity of this Group is now in a production status, however, it remains within the responsibility of the Development Group.

As of the end of 1972, the Region owns three mini-computer systems, a PDP-8/I which is dedicated to the Gerber 22 plotting system, a PDP-8/E which is a desk-top model to be used for surveys where a good deal of general computations are necessary.

The Gerber 22 plotting system has had a very busy year on both production and development projects as can be seen on Figure 49.

The usage as shown on Figure 49 has been mainly on the preparation of field sheet basis, for all of Central Region field parties, and the production of Hyperbolic lattices, for all three Regions as well as Range/Bearing lattices for those surveys using that mode of operation.

Development work for the plotter has been mainly in the area of automatic drawing of soundings for both the Hypos and HAAPS methods of collection. Excellent progress has been made in these areas.

MARINE INFORMATION CENTRE

Nautical Chart Sales

During the past, M.I.C. handled a volume of about 1500 charts. Most of these were free issues supplied to field parties and other sections working in the Centre. Chart sales

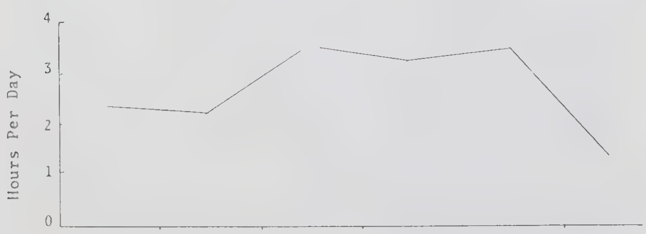


Figure 49. Total Gerber 22 usage.

totalled about 300 for the year which is an increase from last year. Also during the year charts covering the East and West Coasts of Canada were acquired and are stored in the sales office for reference use only. Arctic charts are carried in limited numbers and are available to the public. Topographical maps of Canada are carried also but at present are for reference only, as only one or two prints of each map are in stock.

Marine Information Centre also has a wide selection of publications useful to the mariner and the weekend sailor as well. These list as follows: Pilots of all Canadian waters, List of Lights, Radio Aids, Notices to Mariners, chart catalogues, Water Level information (yearly and monthly), Rules of the Road, and Boating Safety, to mention a few. During the past year, limited use was made of this information and there again mainly by people involved in projects here at the Centre.

Technical Records

The indexing and storage of field data collected during the field season has been continued as established the previous year. Most of this data is stored in the Centre and is readily available to anyone who might require it.

CARTOGRAPHY

During 1972, the Cartographic Section increased its capability of giving cartographic support to the Marine Sciences Directorate, Central Region with the purchase of reprographic equipment in late 1971.

The Morisawa Photo-typesetter has enabled us to supply the various printing needs of the Directorate with a significant improvement in quality and a saving in time and cost. One advantage has been the printing of field sheet titles which previously had to be done by the slower Leroy method. A variety of type styles in a size range of 5.5 to 60 points are available.

The Kodak Ektamatic Processor is used to process the exposed photographic papers used in the photo-typesetter. It is a compact machine which requires very little maintenance.

The Blu-Ray diazo whiteprinter produces ozalid prints of field documents to a maximum width of 42". The machine takes up very little office space, needs only a periodical change of ammonia and has proven to be very economical as many hundreds of ozalid prints are required each year. Diazo transparencies used with overhead projectors are also a capability of this machine.

The Nu-Arc plate maker is used to make film negatives required for the slide-screen printing process. Field sheet titles, publication covers, crests, certificates and displa

igns are a few examples of the type of work done by the creen printing method.

In addition to the reprographic services, drafting upport was given to the Geo-technology Section in the reparation of hydrodynamic and shoreline study drawings.

A responsibility of the Cartographic Section is the originating of supply requisitions for the drafting materials and instruments used by Central Region, both in the office and the field.

In December 1972, Mr. J. Elliott of the Canadian Hydrographic Service, MSD, Ottawa assumed duties as head of the Cartographic Section, Central Region, MSD, in Burlington.

SHIP DIVISION

Launch support was provided so shore based hydro-raphic parties scattered over a distance of some two housand miles east to west from the Lower St. Lawrence o Lake Winnipeg, and north to James Bay via Dartmouth, lova Scotia.

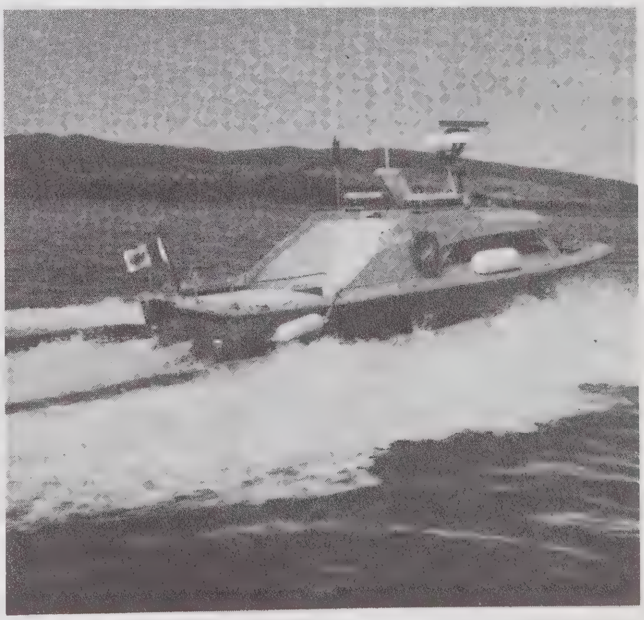
The variety of craft in the regional fleet was increased ven further with the introduction of a new type for use nitially in Playgreen Lake, a shallow, turbid, shoal-strewn ydrographer's nightmare. This was a Mon Ark "Little iant", a 21-foot welded aluminum cathedral hull boat, lmost devoid of beauty but with good practical features, uch as good initial stability, shallow draft and maximum eck space by virtue of a box-like shape. Four of these nits were purchased and in anticipation of numerous roundings, in preferance to inboard or Z-drive (boat-biz erm for inboard-outboard), twin 65 h.p. outboards were elected, with a goodly number of spares provided for quick urnaround. In spite of a few holes, cracks and splits, these raft got the job done in what must be considered a ational proving ground and it is most probable that more f these units, with some strengthening modifications, will e purchased.

The James Bay Project proved to be something of a hallenge. Originally, it was proposed to use four Bertram unches operating from CCGS NARWHAL, a fairly suit-ble ship borrowed, after delicate negotiations, from IOT. Two of these were gasoline engined and two just ecently converted to diesel power. A rather sudden mbargo on ship-borne gasoline storage cancelled out the se of the gasoline launches and the only available ubstitute was a 36-foot steel launch which happily proved be the most suitable for James Bay sea conditions. In ddition to preparation of the launches for a somewhat omplex survey, cradles had to be built, welded to the deck f NARWHAL and lifting gear assembled for hoisting by ARWHAL's great-boom — a hazardous operation even in a state 0. All in all, the launches performed fairly well but ollowing a post mortem it would appear that for James ay, and all points north, an efficient displacement hull of ome 30 feet in length would perform more efficiently than 25 foot semi-planing hull.

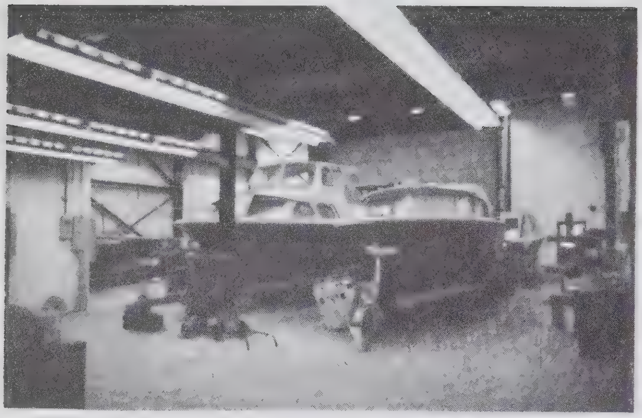
One other innovation, a tunnel-drive launch, conceived as a new weapon in the launch-rock war, did not really get off the ground, as in the first few hours of operation, blocking of the cooling water intake caused major damage to the engine block.

The lion's share of fleet support to limnological programs was devoted to IFYGL. With the exception of five excursions by MARTIN KARLSEN into Lake Erie and the Upper Lakes, principally for monitoring purposes, all major vessel time was devoted to Lake Ontario, extending from March 1972, until April 1973. In this concerted assault on Lake Ontario, LIMNOS completed 73 separate cruises, MARTIN KARLSEN 68 and the chartered tug LAC ERIE, 73.

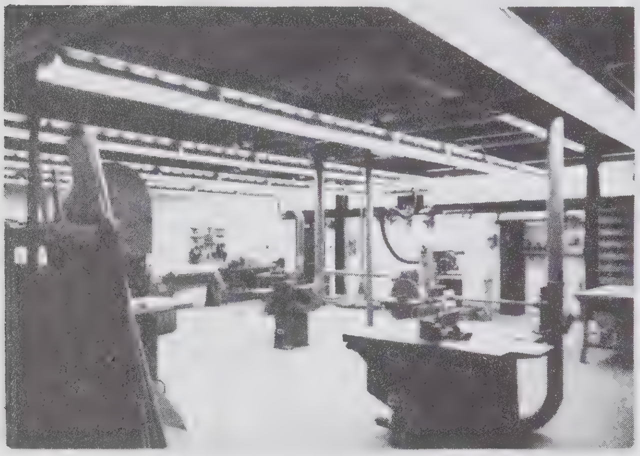
In addition to the larger vessels, the launches AQUA, AGILE, LEMOYNE, STURDY and SHARK were assigned to IFYGL support. A dumb barge, HANDY BOY, was chartered in support of three scientific observation towers on the Niagara Bar. The barge was outfitted with shelter for



CSL BITTERN (Bertram Launch).



Launch repair shop at CCIW.



Ships Division workshop at CCIW.

instruments, recorders and personnel and with a generator for power supply before being strategically moored adjacent to the towers for a six month period.

For the second year a converted landing craft with recessed propellers was chartered for nearshore sediment sampling on Lake Erie, again with considerable success.

The major acquisition was the 77-foot all aluminum vessel ADVENT. Basically a day boat with limited sleeping accommodation, her high speed will enable her to reach th work area from a convenient port with a minimum loss o operational time. A speed of 22 knots has already bee achieved and this may be improved upon with th installation of finer pitched propellers.

RADEL II was finally retired and placed for disposa When last heard of, she was in Midland, being fitted out as pleasure craft.

Two oil recovery vessels, fitted with "slick-licker" unit purchased by MOT were assigned to the Centre. Thes have been operated and maintained by MSD personnel a required.

The launch repair shop experienced its busiest year to date. Most hydrographic survey craft were recalled fo inspection and overhaul and although repairs to engines and outdrives were contracted out every minor hull in the flee was completely refitted. In addition to general overhaul and refits five new launches were modified and outfitted and two launches completely rebuilt.

The ship engineering section continues to be kept fully occupied throughout the year in the repair and maintenance area, both preventive and emergency, to various vessels and related equipment. A good deal of this work which is beyond the capability of shop resources or outside the home port, is contracted out.

The major vessels enjoyed a relatively trouble-free year. LIMNOS experienced one major breakdown, resulting in a loss of 4 days. The cause of the breakdowns, both breakages in a Harbourmaster drive gear, has since been investigated and the cause determined and corrected.

MARTIN KARLSEN continued to suffer a shortage of AC power with the constantly increasing demand. Balancing of loads on the various supplies has relieved the situation to some degree and it is hoped that the addition of an additional 20 KVA motor generator will eliminate the problem for the foreseeable future.

The Centre accommodated a number of participating U.S. and provincial IFYGL craft, while perhaps the highlight of the season was the successful and enjoyable multi-fleet get together and Ship Open House in June.

GEOTECHNOLOGY SECTION

HYDRODYNAMICS

Even though the Section's title, for the sake of brevity and increased generality of functions has been significantly reduced, its overall responsibilities over the past year have grown. In addition to its prime functions of tidal, current, and water level support for hydrographic surveys, and independent hydrographic surveys in the interest of safe navigation, it now has the responsibility for planning and organizing the oceanographic programs to be included in regular hydrographic surveys. Early in the year, an extensive outline of the functions and organization of the Section was developed, including a number of position descriptions.

Current meter installation, Nares Strait in the Eastern Arctic.

In April, N. Freeman assisted personnel of Defence esearch Establishment, Ottawa, in the installation of ırrent meters and thermographs through the ice in Nares rait, to study the mass movement of Polar-deep water om the Arctic Ocean to Baffin Bay. In conjunction with e hydrographic field parties, tidal and inland water level cords were obtained at all of the 1972 field survey cations with the northeast section of James Bay providing to four months of tidal data from some of its eight mporary stations. In James Bay it was found that, due to rge storm seas, island-based tide gauges were difficult to tablish and maintain and coastal locations finally had to selected. A sloping sounding datum was determined for aygreen Lake using past records of Water Survey of anada and a gauging program was developed to verify the lculations. The tidal reduction program obtained from des and Water Levels, Ottawa was adapted to a time-aring system and real-time sounding reductions were ansmitted daily to the Lower St. Lawrence hydrographic rvey party.

Numerous requests from the general public for Great kes water level information were readily answered cause of our terminal connection to the real-time data nk established and maintained by Tides and Water Levels, tawa. A "Water Levels Brochure", explaining the cause d effect relationship of water level variations on the eat Lakes was also produced by the Section, in consulta-n with the Shore Property Studies Section, to facilitate ndling of public queries.

A pressure calibration facility for pneumatic gauges s developed in the Region and five Ottboro gauges were sembled, ten procured from Ottawa, and all fifteen ibrated prior to the 1972 field season. A telemetry tide ıge acquired from Tides and Water Levels, Ottawa was ted locally and field evaluated in James Bay. Even ough difficulties were experienced during its operation, gauge performed well near the end of the survey. Using portions of the Water Survey of Canada strip chart digitizing program, a more expansive digitizing system was developed for the D-Mac pencil-follower so as to include a five-minute digitizing interval and a variable scale.

Oceanographic measurements, consisting of depth profiles of salinity, temperature, and oxygen, as well as plankton hauls and bottom cores, repeated three times during the survey, were taken on James Bay and a Data Report is in preparation.

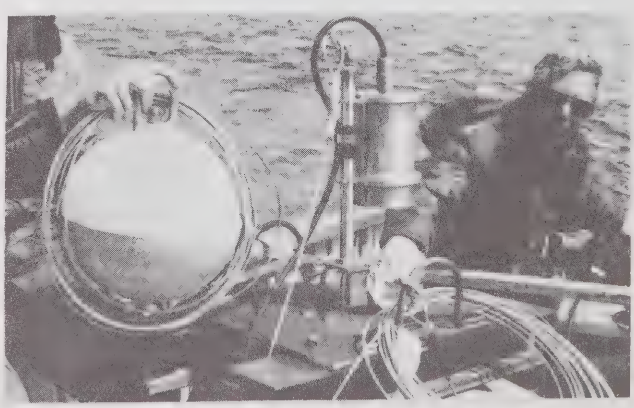
Applied research into storm surges, including numerical modelling and spectral analyses, were undertaken jointly with Shore Properties Studies, and Oceanographic Research Division, MSD to ascertain the spatial and temporal scales of the water level fluctuations, and their effect on hydrographic reductions and shoreline erosion.

Within the next few years, tidal-current surveys are proposed in three areas – the St. Lawrence River from Quebec City to Les Escoumins, the Eastern Arctic and James Bay. In the meantime, various *in situ* tide gauges and current meters are being evaluated and tested along with appropriate mooring systems for multiple environment application (marine, fresh, and Arctic waters). Further oceanographic measurements are planned for James Bay. "Available Potential Energy" calculations will be carried out this winter for Lake Ontario in conjunction with the Energy Budget estimates being made by Dr. J. Blanton for IFYGL. A two-dimensional numerical tidal model is being developed for James Bay to assist in co-tidal chart productions.

Two lectures on Tidal Theory and two on Hydrodynamic Instrumentation were presented to students in Hydrography II course, held this year at CCIW. Also during the year, two papers were accepted for publication.

SHORELINE PROPERTIES STUDIES AND INVENTORY

The concern of the Shore Property Studies Section is the establishment of the data bank for the coastal zone



Remote sensor for telemetry tide gauge.

along some 6000 miles of Canadian shoreline of the Great Lakes and St. Lawrence River and its numerous islands. The basic inventory has existed since 1968 when it was so hastily prepared by the Task Force of the International Joint Commission for the evaluation of the effects of lake level regulation on shore property. Our main role today is to update, expand and adapt it to an ever changing application of its uses. To meet the minimum requirements the section should have staff of 3 full time members and, during concentrated field activities, two part time student assistants, plus continuous support from the cartography section. So far this has been difficult to achieve and since man-years are hard to come by, we must do the best with the resources on hand. Aided for a period of nine months by a graduate geographer who happened to have a commercial pilot's licence, this section embarked on a program of updating shoreline development from the air. During an early part of this year the westerly end of Lake Ontario and the total length of Lakes Erie and St. Clair including Detroit and St. Clair Rivers' shorelines were photographed from an altitude of 1000 feet, thus extending the existing sequential library of colour slides from Kingston to Burlington by the additional 470-mile pictorial record from Burlington westward to Sarnia. This type of inventory is not only practical and vital — especially in an age of long-term planning — but economical costing one dollar and a half per mile of shoreline.

Shoreline erosion.

We have been aware for many years of fluctuations o lake level. That these fluctuations were closely related t erosion and accretion was fully appreciated but seldo measured, and since both land and the water are moving is by no means a simple problem to distinguish their effect Moreover, how does one measure, relative to the prese level of the lake, the height of a raised beach or the exte of erosion? What part of the beach or bluff do you sele for this purpose? There is not one mile of shoreline th has identical characteristics with the next. Not only a precise measurements difficult to make, but also almo every locality has far too few of them. Previously we had be content with qualitative assessments, and howev inadequate our measurements are presently, some quantit tive answers are emerging from the study of storm surge the most devastating villain on the waterfront. To date, tw of these storm surges were analyzed — one on Lake Hur in September of 1971 and a fairly recent one, on La Ontario, the tail end of the tropical storm 'AGNES' in Ju of 1972. The findings for each will be presented in a repo jointly prepared by Shore Property and Hydrodynam Sections.

It will be apparent that the study of the shoreline zo is not only of great interest from a scientific and histori point of view, but that it is also of vital importance fro the economic point of view. It is not easy to find solutio but reasonable ones are much more likely to be obtained those who can see the shore zone as a whole, and can gi time and thought to the problems in question from an ea stage, because more and more care is needed in preservati and proper development. We must observe and collect many facts as possible and try to interpret them in the lig of experience — our own and that of others. Then we m begin to understand how and why change takes place our Great Lakes shoreline and design methods of cont where desirable.

SURVEY ELECTRONICS

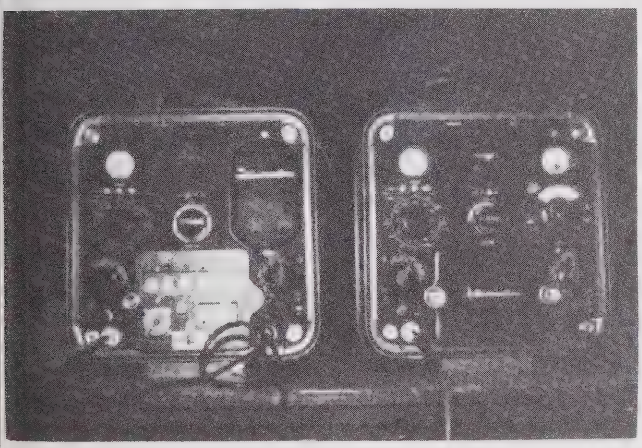
This year as always, the Electronics Shop w extremely busy. The Electronic Technicians' strike star the year off badly, but the late departure of most fi parties tended to offset the time lost due to the strike.

Technicians were in the field with survey parties ba at: Playgreen Lake, Lake of the Woods, Lower Lawrence, and James Bay. In addition, Revisory Surv Navigational Ranges, Dr. Rukavina's Near Shore Survey IFYGL were supported by technicians based at Burlingt

The James Bay Survey was probably the most manding so far as the Electronic Shop was concerned addition to the technician stationed with the party, additional technician sailed with the NARWHAL to from the operations area.

The James Bay Survey utilized the first fifty v Mini-fix chain to be used in Canada. As a result of

Electronic shop at CCIW.



MRB 201 Digital Hydrodist.

increased power, ranges over 100 miles were regularly achieved. In association with Hydrodynamics a telemetering tide gauge was also employed, however, with limited success. The James Bay Survey also used the Mufax weather receiver that formerly was aboard the CSS LIMNOS.

The IFYGL project also heavily taxed the resources of the Electronics Shop. In addition to the early outfitting of launches, we provided seven CH25 radio-telephones channelled to special IFYGL frequencies. Ground to air radio telephones and a CH25 were supplied for the Lac Erie, and a radar was supplied and installed aboard the Ontario Ministry of Natural Resources vessel COTTUS. In anticipation of possible future use of a Decca system, two of our technicians spent two weeks at the Decca stations. As usual, a considerable amount of time was spent supporting the scientific launches, working with IFYGL and separate from IFYGL.

The Hydrodist readouts that were designed by a technician from the Electronics Shop and built by C-Tech were used in the field for the first time, and from all reports worked very well and eased the strain of using Hydrodist. The new Hydrodist 201's were also used for the first time. New VHF radio telephones were evaluated, purchased and supplied to the Playgreen Lake Survey.

During the year the electronics shop acquired an additional room thus facilitating the physical and structural breaking of the shop into three areas: sonar, systems and communications.

Other areas of present involvement, in addition to the yearly overhaul, include: modifications to the Sea Fix Buoys, rebuilding of the Gifft Sounder, remote readouts and left/right indicators for the RPS, and assembling of a data recording system for Dr. Rukavina's Near Shore Program.

ADMINISTRATION

PERSONNEL

The personnel office is responsible for the orderly processing of 152 man-years complicated by the seasonal status of 101 ships crew positions. At seasonal peak 207 employees were held on strength — 1972.

Although delegation of staffing authority does not rest with the Regional Director; recruitment, documentation and most processes are handled at the Regional level with the MSD personnel Advisors office responsible for ensuring that the principles of the merit system are met.

Effective January 1, 1973, Central Region will be served by a DOE Regional Personnel Organization presumably with offices located at CCIW Burlington, thus severing personnel administrative relations with the Director General's office in Ottawa.

During the first nine months of the current fiscal year 15 full time continuing personnel were staffed and administered through this office and 127 seasonal and casual employees processed.

Services provided at the local level as follows will continue:

1) employment and discipline
2) leave and compensation
3) training and education
4) staff relations
5) security
6) staff benefits

7) health and safety
8) pay and benefits
9) man-year utilization control etc.

Close to 50 Position Analysis Schedules have been written with the aid of private consultants over the period and processed to Ottawa for classification action.

ACCOUNTS

Of a total regional budget of 4M annually, 2.4M is processed through the Accounts Office representing $500,000 in 12 field account activities, 1.5M general O&M purchases and ships charter and $300,000 in capital expenditures.

The remaining 1.6M represent salaries and other personnel costs.

Payment of accounts formerly handled through MSD headquarters is now processed direct through the Regional Services Office of DSS Toronto.

The preparation of field accounts, pre-audit for payment etc., occupy much of the staff's time during the summer field season.

Increased costs of services and supplies over the past year have forced some cutback in operational programs placing the accounts section on the alert for possible savings and tighter control of proposed spending.

The work is accomplished by three Accounts Clerks.

SUPPLY SERVICES

Organization

Supply Services are centralized under the Regional Administrative Officer and consist of a Hydrographic Stores located within an enclosure in the main CCIW warehouse, and a ships stores located some 100 yards distant in a stockroom adjacent to the boatshop. A small office in this same area houses procurement and stock control. Bulk warehousing is provided by the IWD (Scientific Support Division).

A study is currently underway to determine the feasibility of amalgamating all general purpose stores at CCIW.

Scope

Approximately 6000 accountable line items are held on MSD — Central Region charge, having a value of $12M. In the first three quarters of 1972-73 over 1000 requisitions were processed covering supplies and services for which $1.5M was committed. The controlled mobility of this inventory in support of both ship and shore based field parties operating from the high Arctic through James Bay, and the Great Lakes to the Gulf of St. Lawrence is a major concern of the Supply Services staff.

A heavy vehicle commitment to mobile field operations is demanding considerable attention under the departments vehicle fleet management system.

Inland Waters Directorate (Ontario Region Operations)

WATER PLANNING & MANAGEMENT BRANCH (ONTARIO REGION)

On September 5, 1972, the Burlington Office of the Water Planning and Management Branch (Ontario Region) commenced operation as part of the Regional Office, following the transfer from Ottawa of the positions and staff of the former Central Region, Engineering Division of the Branch. A second Office of the Ontario Region of the Branch is located at Cornwall, Ontario (Great Lakes–St. Lawrence Study Office). Mr. N. P. Persoage has served as Acting Head of the Ontario Region since September, 1972.

The two offices of the Branch carry out extensive studies related to water management problems in the Ontario Region and members of its staff serve on a number of Engineering Boards and Boards of Control on the Great Lakes established by the International Joint Commission and several joint Canada-U.S. International Committees. Emphasis during the past year has been on that aspect of the Region's work dealing with regulation and control of the Great Lakes–St. Lawrence System. In recent months, extreme high lake levels on the Lower Great Lakes have been of particular concern and have required extensive studies of possible methods of alleviating high water on Lakes Huron, Erie and Ontario.

At the Cornwall office preparations were made and methods developed to begin issuing to the public six-month forecasts of Great Lakes levels, beginning early in 1973.

A more detailed review of these activities will be contained in the annual report of the Water Planning and Management Branch for fiscal year 1972-3.

WATER QUALITY LABORATORY & NETWORK (ONTARIO REGION)

In March, 1972, the analytical services laboratories of the Water Quality Branch moved from Ottawa to the Laboratory and Administration Building at CCIW. The unit's detachment that had been located in the Pilot Plant at the Centre also moved into the Building at about the same time. The Water Quality Laboratory consists of three Sections: Analytical Services, Special Services, and Great Lakes and Ships Support. Recruitment is underway to staff the Monitoring and Surveillance (field) Section that will be responsible for planning water quality monitoring and surveys to assess the quality of the water resources in the region.

ANALYTICAL SERVICES SECTION

This Section consists of an Inorganic Analysis Laboratory, which determines major ions, trace metals, and other inorganic constituents of water, and an Organic Analysis Laboratory which determines nutrients such as phosphates and nitrates and trace organic contaminants such as pesticides herbicides, oils and polychlorinated biphenyls. Two of the major projects for which the Analytical Services Section provided support in 1972 were:

1) National Water Quality Monitoring and Surveillance—The Water Quality Branch collects water samples at selected locations throughout Canada for analysis and reporting of water quality on major lakes and rivers. The objectives are to obtain baseline data to identify and predict trends, to act as a pollution warning system and to assist in the enforcement of pollution control legislation. The laboratory at CCIW analyzes samples collected from stations in Ontario and Quebec. At present, there are eighty two stations in Ontario including ten stations on Lake Ontario, eleven on Lake Erie, twenty on Lake Superior and thirteen on Lake Huron. There are thirty-four stations in Quebec.

2) Pesticide Survey of the Lower Great Lakes—This is a special survey to determine the presence and quantity of hydrocarbon pesticides (such as DDT and its derivatives, and including polychlorinated biphenyls) in samples of water, plankton, sediments, and fish collected from the lakes.

A total of 72 projects were supported by the Analytical Services Section.

Other Work: Pesticide Method Development. The Organic Analysis Laboratory developed methods for analysis of herbicides and organophosphorus pesticides and also published a manual on methods of analyses for chlorinated hydrocarbon pesticides. In addition, this laboratory developed a method for the confirmation of pesticides using a solid matrix technique which is simpler and more sensitive than the customary solution derivation technique.

Determining trace amounts of organic constituents in water by gas-liquid chromatography.

This method, which has been adapted for routine use, has been the subject of four papers published in 1972.

In the course of the year the Analytical Services Section conducted about 70,000 analyses on 4,300 samples.

Special Services Section

This Section consists of two groups: a Special Analysis and Quality Control Laboratory, and a new Methods Development Laboratory for which staff is currently being recruited. The Special Analysis and Quality Control Laboratory has been engaged primarily in the following two projects:

1) Quality Control. The Laboratory conducts a National Interlaboratory Quality Control Program in which there are currently 25 participants including federal and provincial government laboratories, universities and industrial laboratories as well as the regional laboratories of the Water Quality Branch. Samples are sent to participants for analysis and the results are reviewed and reports written with the objective of evaluating test methods and evaluating the performance of the participating laboratories. During the past year two studies were conducted; one on metals (chromium, iron, molybdenum and vanadium), and one on physical properties (pH, specific conductance, color and dissolved solids).

2) NTA Monitoring. A major effort of the Special Analysis and Quality Control Laboratory this year was in the determination of NTA (nitrilotriacetic acid), in support of a number of programs. Some 400 samples of river, lake, ocean and groundwater were analyzed as part of a program which had as its objective the determination of background levels of NTA in the environment. In addition, more than 3,000 sewage samples were analyzed for the Environmental Protection Service at CCIW in connection with studies on various aspects of the degradation of NTA in sewage treatment plants. A good start was made on the National Monitor Program for NTA on analysis of samples from Great Lakes, ground, surface and marine waters and finished waters from municipal water treatment plants at selected sites across Canada.

GREAT LAKES AND SHIPS SUPPORT LABORATORY

This Unit operates laboratories aboard research vessels operating out of the Centre to determine those constituents which must be determined immediately after collection. The Unit is also responsible for some of the further testing on samples returned from the ships to the main laboratory and on other projects. During the past year approximately 7,000 samples were analyzed aboard ship for soluble reactive phosphorus, silica, ammonia, nitrate plus nitrite, total soluble nitrogen, total alkalinity and chloride. The Unit conducted about 130,000 tests during the year including 53,000 aboard ship and 77,000 in the shore laboratory.

Some of the projects which this Unit supported during the past year were:

IFYGL—The laboratory participated in seven 2-week Organic Particle Study cruises on Lake Ontario

Atomic absorption spectrophotometer being used to determi parts per billion levels of metals in water.

as part of the IFYGL Program.

Great Lakes Monitoring—In addition to the IFYGL cruises, the laboratory participated in one biochemical monitor cruise on Lake Ontario, three on Lake Erie, and three on Lake Huron, one of which included Georgian Bay and northern Lake Michigan.

Precipitation Chemistry—A total of about 260 precipitation samples were analyzed for pH, total alkalinity, soluble and total nutrients, major ions and some trace metals.

Interlaboratory Comparisons—The laboratory was involved in a number of comparisons among the laboratories involved in the IFYGL Program to ensure that the data produced by the laboratories are comparable. The laboratory was given the responsibility of collecting and distributing "split" samples of Great Lakes water to the other laboratories as part of the intercomparison program.

In addition to the above programs the laboratory has provided support to a number of smaller projects and conducted some investigations into methods of analysis and preservation of samples, particularly with reference to shipboard analysis and preservation.

Special Studies

1) Investigations into the effect of freezing of lake water samples prior to analysis.

2) Development work was conducted to ensure that the new AutoAnalyser II systems were producing data comparable to the older AutoAnalyser I systems, the latter

The twin cell polarograph is used to determine NTA (nitrilotriacetic acid), a replacement for phosphates in detergents.

which are gradually being replaced.

Contracts 1972

The following private sector-branch contract from headquarters funds was monitored by W.J. Traversy:

Environmental Distribution of Agricultural Chemicals (Canadian Canners Limited Research Centre).

Central Services (Provided by Inland Waters Directorate)

CANADIAN CENTRE FOR THE INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

The year of field work commenced on 1 April, 1972. The final details of this field operations phase were hammered out, and coordinated internationally, during January. Complete program details were assembled and published in a four-volume Technical Plan.

An IFYGL Bulletin was established to give a running account of Canadian and United States participation. The Canadian section of the IFYGL Bulletin was edited by the Coordinator. A summary of the Canadian field operations was published in Bulletin 2, further details on instrumentation systems were in Bulletin 3, in Bulletin 4 (September 1972) there were some preliminary results available on the heat content of the lake, and in Bulletin 5 some results of the Canadian fish survey (Ontario Ministry of Natural Resources) were included.

PROGRESS DURING 1972

As an essential preliminary to the field work, a Decca 6F position fixing system was set up and its cost shared between Canada (Central Region, Marine Sciences Directorate) and the United States (National Oceanographic and Atmospheric Administration).

The three major Canadian vessels (Limnos, Martin Karlsen and Porte Dauphine) commenced work in April, 1972, and were joined by two major United States ships as soon as ice conditions in the St. Lawrence allowed them to enter the lake. A field comparison between the various ship-borne measurement systems was held on 26 June, and 18 September, 1972.

By the end of December 1972, 82 Canadian ship cruise reports were filed. The cruises monitored the lake-wide network of buoy-borne instruments, surveyed the state of the lake and supported the special investigations of universities and other agencies.

The Canadian half of the 21 buoy, lake-wide meteorological and limnological observing system was regularly maintained, and six towers were installed and manned for studies of the interaction between the atmosphere and the lake. Frequent cruises were undertaken to examine lake thermal structure, heat budget and primary production in surface layers. Preliminary lake heat budgets were computed using data from both Canadian and United States vessels.

In the biological-chemical program, seven 1972 research cruises were carried out staffed by CCIW (FRB & IWD), McMaster, and Guelph University investigators. The objective was to study the interaction between chemical and biological processes. The two-week duration cruises included a period of 48 hours at two fixed locations in order to describe and understand the daily changes in the biological and chemical activity. Synchronized fish surveys were carried out by the Ontario Ministry of Natural Resources working in direct cooperation with United States federal and state agencies. Nine such cruises comprised this program.

Sophisticated techniques were used on the towers for directly measuring the transfer of heat, vapour, and wind stress between the atmosphere and the lake. Investigators from the Atlantic Oceanographic Laboratory, Dartmouth, Nova Scotia, the Atmospheric Environment Service, Toronto, or the Canada Centre for Inland Waters, Burlington, were working during the pre-arranged two week duration alert periods in May, June, August and October. The many-agency interest is due to the fact that these experiments have application to the improvement of prediction of lake and ocean currents, long period weather forecasting, waste heat dissipation, waves, limnological productivity and atmospheric pollution.

The hourly results of the six Canadian Lake level gauges were published. These showed that the level of Lake Ontario, rose rapidly to a peak in July at 246.68 feet above mean sea level at Father Point, Quebec. This level was the highest since 1952 and has only been exceeded eleven times in the last 100 years. In other respects too the year has not been a normal one. When the program started the average lake temperature was 2.9°C, 0.9°C colder than normal for early April. April 1972 was one of the coldest Aprils on record with temperatures 2 to 4°C below normal. There was an early summer storm (fringe of Hurricane "Agnes"), and an outbreak of cold air on 8/9 October, in the middle of the October alert period. These circumstances were considered to augur well for the success of the IFYGL, since a more than usually large range of parameter variations was encountered. Several well marked wind stress impulses occurred which will be helpful in understanding the dynamic response of the lake.

Six stations were set up around Lake Ontario (Canadian stations by Atmospheric Environment Service,

Environment Canada) to conduct upper air soundings during the fall and to measure the atmospheric flux of water vapour across the lake when evaporation was at a maximum. The stations were operational as planned on 16 September, and continued operations until 7 December, 1972, by which time the three Canadian stations made about 1500 radio soundings of atmospheric winds, temperature and humidity from the surface up to a height of over five miles above the surface.

Three weather radars have maintained an almost continuous watch on the rain in the basin, working together with networks of conventional rain gauges. The Canadian radar was located at Woodbridge, Ontario, and designed to prepare quantitative estimates of precipitation over the northwestern portion of the Lake Ontario drainage basin. A network of 12 precipitation gauges was located near Bowmanville (72 km from Woodbridge), and 9 gauges were placed near Uxbridge (12 km from Woodbridge) to assist in calibration of radar precipitation estimates.

The international fish sampling program took 100,000 samples and noted 53 different species.

Data was acquired by the Canada Centre for Remote Sensing. Department of Energy, Mines and Resources, which proved useful for defining the extent of *cladophora* beds in the eastern half of the Ontario near-shore zone.

It is already clear that the major part of the field program has gone as planned and acquired useful data from April 1972. Some elements of the program did not start up until June or July. The impact of these delays was assessed by the IFYGL Steering Committee and not considered serious enough to warrant any major extension of the program beyond 31 March 1973.

DATA

A detailed study was made of the Canadian Data, and formats for summarization (e.g. hourly value tables, etc.) were drawn up and published in Proceedings of IHD Workshop Seminar, Quebec City, October 1971. The Canadian Data Bank is located at CCIW and is now accumulating both raw and worked-up data from Canada and the United States.

SCIENTIFIC ANALYSIS

Preliminary studies have commenced in Canada. For example, CCIW investigators made a preliminary analysis of the lake water temperature data obtained by both Canadian and United States vessels, and Ontario Ministry of Natural Resources biologists have compiled preliminary fish distribution data.

Wind stress on the lake has been computed by CCIW from the results of the meteorological buoy measurements. The results of the CCIW lake-wide current measurements are available.

Dr. G. T. Csanady, University of Waterloo, has commenced the analysis of the IFYGL Coastal Chain project. This work seems to indicate that the circulation of the lake is episodic, rather than continuous. For each occasion of major wind stress the lake has a characteristic response which then dies away in two or three days. Marked reductions in the anticipated effect of a given wind were noted in spring due to the great stability of the air when moving over cold water. The work also appears to be useful in illuminating certain oceanographic problems. In Lake Ontario these can be studied without interference from significant tidal or salinity factors.

PUBLICATIONS

The IFYGL Coordinator, Mr. J. MacDowall, edited the Canadian part of the International IFYGL Technical Plan and Bulletings, the IFYGL Technical Manuals and compiled the proceedings of the IFYGL Biology-Chemistry Panel Meeting.

REMOTE SENSING AND DATA RETRANSMISSION BY SATELLITES

Mr. J. MacDowall assisted the Canadian Advisory Committee on Remote Sensing by serving as Vice-Chairman of their Working Group on Sensors, and as a member of the Working Group on Data Retransmission by Satellites. The second year's results from the Sensor Program was edited by Mr. J. MacDowall for publication by the Canadian Aeronautics and Space Institute Journal.

SCIENTIFIC SUPPORT DIVISION

The Scientific Support Division provides the major portion of the technical and professional support for the scientific programs at the Centre, as well as undertakes some applied research and development in such areas as Radio-chemistry and Instrumentation. It consists of five components, the activities of which are described below.

SCIENTIFIC SERVICES

Two types of laboratory activity, radiochemistry and electron microscopy, are the concern of this Section. These activities support the scientific program of CCIW through joint research projects with scientists from other CCIW components. The radiochemistry laboratory is equipped to handle medium radiation levels safely and has instrumentation for γ-ray spectrometry and low-level β counting. The electron microscope laboratory uses a Siemen's transmission electron microscope for morphological studies of bacteria and sediments and for crystal structure determination by electron diffraction.

Radiochemistry

At the present time, radionuclide levels in the Great Lakes are still due to fallout from weapons testing in the atmosphere as the nuclear power industry is still in its infancy. As a preliminary to making a baseline assessment of the radionuclide loading of the Lakes it was necessary to determine the counting efficiency of the lithium drifted germanium γ-ray detector for the more usually encountered radionuclides. After this was completed an intercomparison of methods for analyzing water samples for γ-ray emitting radionuclides was entered into with several U.S. laboratories under the auspices of the United States Atomic Energy Commission (U.S.A.E.C.). A sample of Lake Michigan water, spiked with low levels of ^{60}Co, ^{144}Ce, ^{65}Zn, ^{54}Mn, ^{134}Cs, and ^{137}Cs, by the National Bureau of Standards, was circulated to each laboratory along with an unspiked sample for analysis. Our results for the spiked sample were in very good agreement with the mean values from all the reporting laboratories while our result for Lake Michigan water at 0.085 ± 0.015 pico-Curies (pCi) per litre was close to the mean value also.

The quantities of radionuclides in lake sediments are of interest as they constitute a substantial fraction of the lakes' loading of radionuclides while the vertical distribution of the radionuclides in the sediments can provide information on sedimentation rates. A large sample of the top layer of Lake Ontario sediment was analyzed by wet chemical methods for radionuclides other than those occurring naturally and ^{144}Ce, ^{137}Cs, and ^{90}Sr, were found. The γ-ray emitting radionuclides were then analyzed for in sections of cores taken from various locations in Lake Erie by direct counting of the freeze-dried sections with a low-background Ge(Li) detector. The levels of ^{90}Sr in the 1 cm. core sections were not distinguishable from background with the present counting system which corresponds to about 0.2 pCi per gram of dried sediment. The distributions of ^{144}Ce and ^{137}Cs in the cores from the western end of Lake Erie were quite different from elsewhere in the lake. The level of ^{137}Cs in the western cores was reasonably constant down to 13 cm. then below this depth it dropped off sharply to zero. In the central basin, however, its level was higher in the first few centimetres but it tailed off at a depth of 6 cm. The behaviour of ^{144}Ce was similar but the levels were lower and the penetration somewhat less. These radionuclides most likely precipitate from the lake water as complexes with organic material, therefore, as nuclear weapons fallout only started to become appreciable from 1959, the 6 cm. in the central basin represents an average sedimentation rate of about 5 mm. per year. It is unlikely that the sedimentation rate in the western part of the lake is twice as high as this, as the two-fold deeper penetration of ^{137}Cs would suggest. It is more probable that the high turbulence in this shallow basin caused by frequent seiches, stirs up the sediment to an appreciable depth.

Neutron activation analysis for oil for trace elements as a means of identifying the source of an oil spill produced results which suggest that trace element "finger-printing" may not be as meaningful as was first thought. A can of Western Canadian crude from a local refinery storage tank was analyzed several times using different sampling methods. It was sampled directly from the container and also after heating the container to 40°C and stirring vigorously. The samples were sealed in quartz vials and irradiated in the McMaster University Nuclear Reactor along with known quantities of the elements being analyzed for. After irradiation the oil samples were transferred from the quartz vials to glass counting tubes and the counting rates of the specific γ-rays from element standard and sample compared to obtain the concentration of the element in the oil. The results in the table show that the concentrations of these elements are very dependent on sampling technique and could cause loss of correlation between spill and source.

Element Concentration (ppm)

Treatment	Co	Fe	Zn	Ni	Cr
Heated & Stirred	0.021	15.6	0.37	6.3	0.16
No Stirring	0.012	<1	0.05	3.9	0.01

This was borne out by analysis of a slick of light fuel oil and a sample from the hold of the tanker which produced the spill at a local loading dock. Preliminary results showed the copper content of the tanker sample to be much higher than that of the slick. Experiments are continuing to determine the effect of water contact on the trace element concentration.

Neutron activation analysis has also been used to trace nearshore sediment movement in the western end of Lake Ontario in cooperation with the Geolimnology Section. Glass containing about 4% antimony was made in 50 Kg batches at the School of Design, Sheridan College, then ground and sieved to produce a product with a similar size distribution to the sediment. About 15 Kg of this material was embedded in the lake bottom about a quarter of a mile offshore where the depth of water was about 7 metres. Periodic core sampling of the sediment on a grid pattern around the spiked glass was done by divers and dried sections of the cores were analyzed for Sb by neutron activation analysis. About 100 mg samples were sealed in quartz vials and irradiated seven at a time along with an Sb standard in the pneumatic carrier facility of the reactor for 5 minutes. The vials were counted unopened for ^{122}Sb after a period of 5 days to allow the preponderant ^{24}Na activity to decay. The limit of detection of Sb using this technique was about 1 ppm which was well above the background level of Sb in the sediment. This was determined initially using a much longer irradiation period and found to be less than 0.1 ppm. About 420 samples were analyzed with the results giving a clear indication of the direction and rate of sediment transport.

Electron Microscopy

Several techniques have been developed to study the external and internal ultra-structure of bacteria isolated

Figure 50. NTA degrading bacteria, negatively stained by ammonium molybdate.

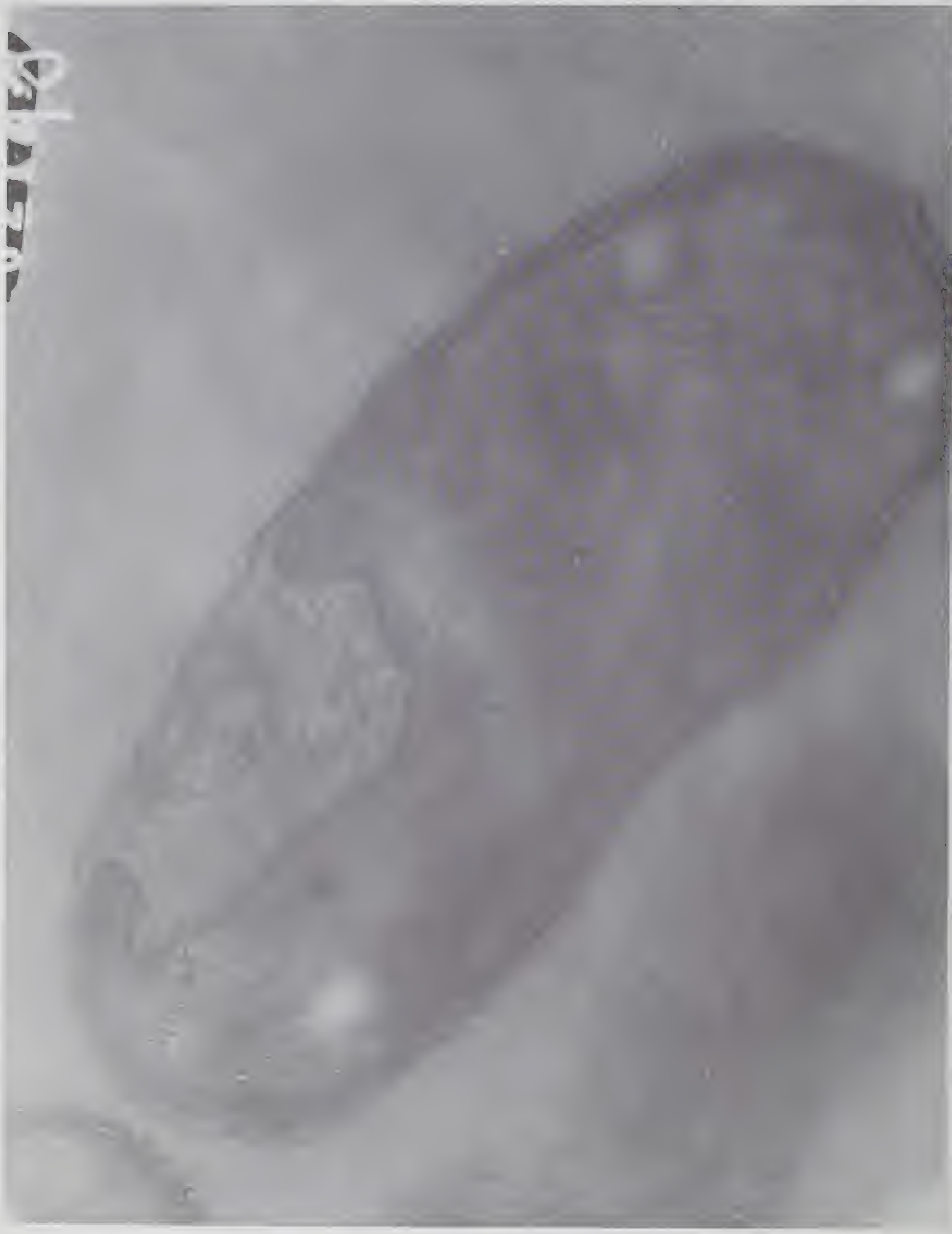


Figure 51 Thin section of NTA degrading bacteria.

from lake water, sediments and soil, and also the crystal morphology and structure of the lake sediments.

Bacteriological Specimens

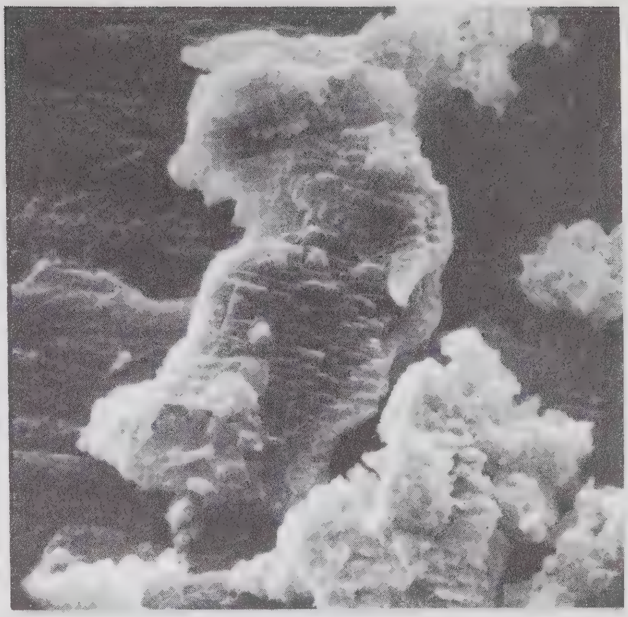
Negative staining makes use of the principle of surrounding the bacteria with an electron dense material of high atomic number. This procedure preserves the three dimensional structure and the stained bacteria appear as electron-transparent objects against a relatively opaque background. Phosphotungstic acid and ammonium molybdate at 2% concentration and pH 6.0 have been applied quite successfully in the determination of the external features of the NTA degrading mutant (Fig. 50). Other similar bacteria isolates prepared by the Microbiology Section such as those which degrade PCB's have been examined using this procedure.

A thin sectioning technique has been developed to examine the microbial cell wall, internal membranes and the macromolecular aggregates within the cell. It involves sectioning bacteria with an ultramicrotome after fixation, dehydration, staining and embedding in Epon 812 resin. The two aims are to preserve the structure of the cell and to obtain thin sections of the cell between 50 and 100 nm in thickness. This is the optimum thickness for observing this type of specimen with the transmission electron microscope. The technique has been used in the examination of the internal structure of NTA degrading bacteria (Fig. 51).

Sediment Specimens

Particles which are insoluble in water are dispersed ultrasonically in water to form a dilute suspension and a small drop of the suspension transferred to a carbon coated grid. The excess water is removed with filter paper whereupon the particles settle onto the carbon film. With this technique, calcium carbonate precipitates from Kalamalka Lake, British Columbia, have been examined. Figure 52 shows the two main constituents of the sediment which are skeletons of diatoms and calcium carbonate crystals in the size range 0.5 to 5 um. From micro-electron diffraction analysis of individual particles, they were identified as calcite with a hexagonal crystal structure. Their morphological features, which were examined with a scanning electron microscope at the University of Toronto suggested that the calcite crystals at an original crystal surface and by dentritic growth by nucleation of new crystals at an original crystal surface and by dentritic growth with preferred orientations. Aggregation of small crystals into larger units was also observed.

Particles which are soluble in water are dispersed in butylphthalate and embedded in a thin film of formvar. The film is scored and a small section is transferred to a carbon coated grid. The formvar is then dissolved in chloroform and the particles settle on to the carbon film. This method has been developed to examine powdered samples from manganese-iron nodules of Lake Ontario.



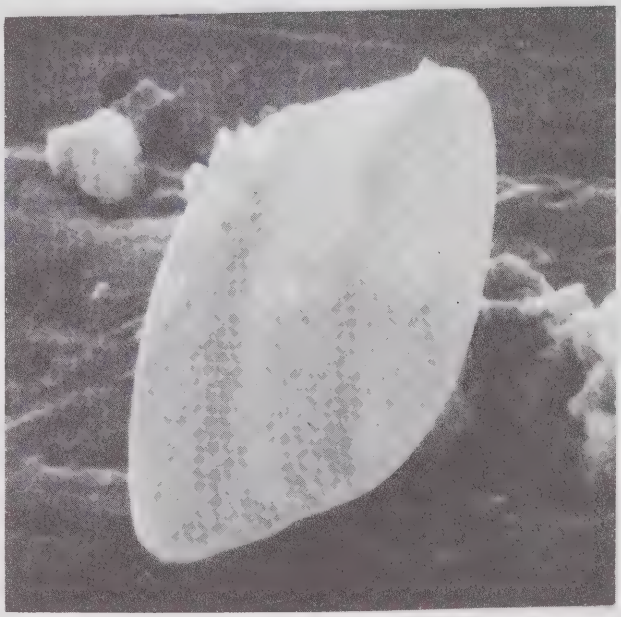
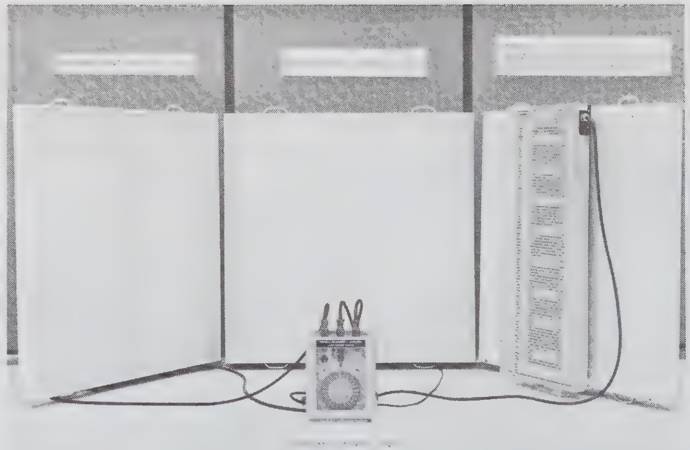


Figure 52. Calcite crystals and a diatom skeleton from sediment of Kalamalka Lake, British Columbia.

ENGINEERING SERVICES

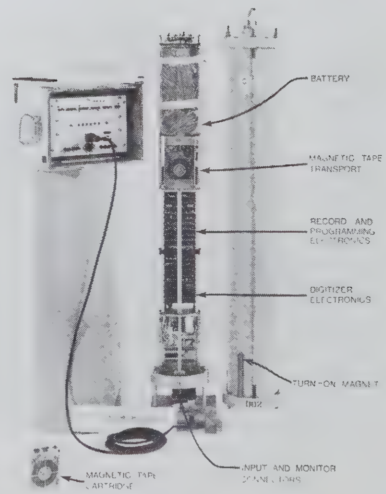
The Engineering Services Subdivision provides engineering support services upon request to all other sections, groups, and divisions at CCIW. These services range from innovative design and development, through various equipment upgrade and improvement programs, to preventive and corrective-maintenance performed on the substantial CCIW instrument inventory. This support includes both electronic and mechanical engineering, technical drafting, and provision of workshop facilities. In 1972, by far the

INCOMING INSPECTION ON DIGITAL MONITOR PRINTOUT UNITS MANUFACTURED FOR C.C.I.W. BY CANADIAN ELECTRONICS INDUSTRY



PROTOTYPE AUTO-PROGRAMMED LIGHT-CONTROL SYSTEM DEVELOPED FOR USE IN FISH AND PLANT-LIFE POLLUTION STUDIES

TOWER-MOUNTED ENVIRONMENTAL-SENSOR ARRAYS USED IN LAKE ONTARIO



ELECTRONIC DIGITIZER FROM THE C.C.I.W. MOORED TEMPERATURE-PROFILING SYSTEM USED FOR LAKE HEAT-BUDGET AND INTERNAL-

major portion of these engineering activities were in direct support of the International Field Year for the Great Lakes (IFYGL).

Described below is a summary listing of the major engineering projects, systems, or equipments requiring significant engineering participation during the year, together with a brief description of the support given to each.

Moored Meteorological Buoy Systems

A major IFYGL project was supported by providing some 20 buoys, 20 digital data-loggers, and 120 air and water sensors to maintain 11 buoy-stations in Lake Ontario. Data-logging equipment maintenance and improvements were sub-contracted to Canadian General Electric, digital timers and digital test monitors to EDA Electronics, and much of the sensor calibration to the Atmospheric Environmental Service of our Department in Toronto. Data translated from the metbuoy field tapes totalled over 1 million, with a data-recovery factor of over 90%.

Moored Current-Measuring Buoy Systems

About 80 current meters were provided and calibrated to equip 15 buoy stations in Lake Ontario, with up to 4 current meters per station. Again this work was contracted to Canadian industry, with separate sub-contracts for digital clocks, CMOS modules, low friction swivels, etc. Current meter refurbishments, including those for winter under-ice moorings and subsidiary programs, totalled about 140. With the bulk of the 1972 data tapes translated, a mean data-recovery of 80% on about 1.5 million data points has been obtained.

Shoreline Temperature Stations

Complete instrumentation systems for seven shore stations were engineered and extensive field support was provided during 1972. This equipment included spar buoys, cables, surface and bottom temperature sensors, analog chart displays, and some phoneline telemetry facilities. Notwithstanding problems from dredging, radio frequency interference, lightning, and major shoreline erosion during storms, a satisfactory degree of data-recovery was achieved for the IFYGL.

Micrometeorological System

This extensive barge and tower mounted instrumentation system, used as a component of the IFYGL Boundary-Layer Program, received major engineering support in 1972. Design, development, fabrication, assembly, test, and calibration services were provided to each of its three major sybsystems: the Integrated-Flux, Air/Water Turbulence, and the Wind-Profiling subsystems. A total of about 50 environmental sensors were involved, with three main data-acquisition systems storing meteorological data on magnetic or punched-paper tape, and all mounted on a barge and two towers. The towers required extensive modifications to accommodate the instrumentation and a roving probe was developed for the Profiling Subsystem. This probe consisted of an anemometer, an air temperature sensor, and a relative-humidity sensor, all of which were identical to those located at five fixed levels in the subsystem. The carriage for the probe was an automated welding carriage, modified to accommodate the instruments and suitably weatherproofed. The probe stopped automatically at each sensor level long enough to record two or three sets of data. In this way, data from all sensors were compared to a common set and the subsystem thus was self-calibrating.

Rotatable supports were built to hold direction-sensitive instruments for the Turbulence Subsystem, such as the sonic anemometer and hot wire anemometers. These platforms on the towers were rotated by T.V. antenna rotors controlled remotely from the nearby barge, where a readout enabled the sensors to be pointed in any desired direction.

A rotatable support was also built to hold two wave probes and an electromagnetic current meter. This support was rotated by a heavy duty T.V. antenna rotor which was remotely controlled so that the support could face into, or away from the waves. The frame that held the current meter was vertically operable from the barge, so that the current meter could be set at any depth in the water between zero and ten feet. Other work included remotely operable rain shields for two hot wire anemometers and one Lyman α humidity sensor.

The Flux Subsystem required that two wind vanes and one self-aligning Thornethwaite Flux Meter have heavy damping, but also be capable of reacting to low wind velocities. This was resolved by attaching each wind vane to a dashpot filled with silicone oil; inside each dashpot were two modified model aeroplane engines at 90° to each other. An eccentric bearing attached to the wind vane shaft actuated each piston, which pumped the oil through a controlled orifice. For low turning speeds the wind vane had negligible torque resistence, but as the speed increased the pressure inside the engine cylinder increased giving progressively greater damping.

Moored Temperature-Profiling Buoy System

Again significant design engineering was provided to these 18 channel, automatic, temperature-data-acquisition systems, four of which were maintained on station during the Field Year. Performance of the 120 system sensors, the five electronic digitizers, and the buoy moorings was most satisfactory during the year. Cable flexing problems was the major contributing factor to the 70% data-recovery for this system, however, extensive new time-series scientific data were obtained with this equipment.

Electrobathythermograph (EBT) Systems

A total of 14 systems were procured, installed, calibrated, and maintained during 1972 for a variety of the IFYGL programs. Platforms used were major ships,

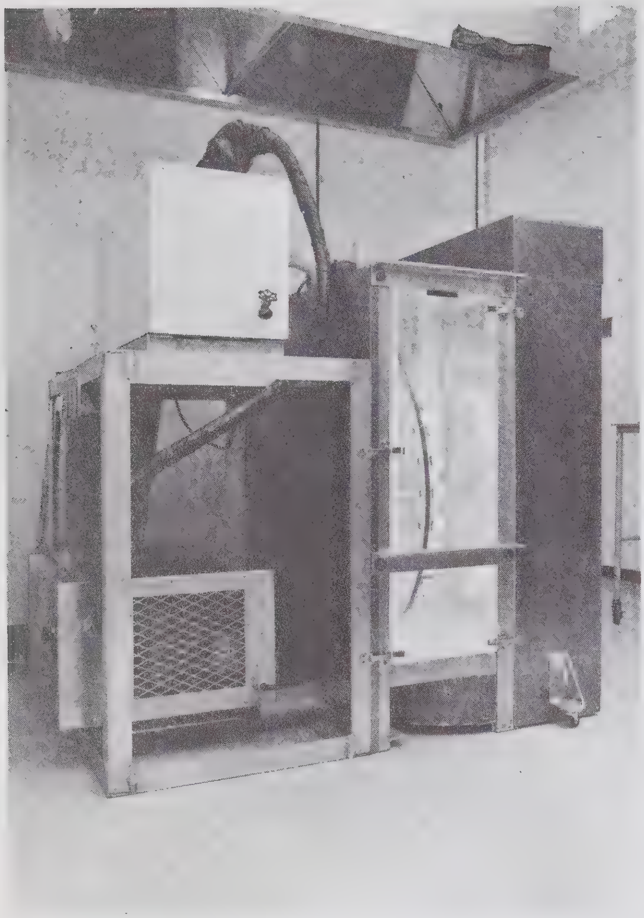


Figure 53. C-14 Incubator.

launches, the "Batfish" towed body, and a pumped sampler. System engineering responsibility embraced the temperature/depth probes, armoured cables, winches, winch control units, sliprings, probe calibration units, and X-Y displays. Several thousand detailed and valid lake-temperature profiles were generated with these equipments.

Towed Temperature-Profiling System (Thermistor Chain)

Engineering support provided for this important data-gathering system included the specifying and procuring of the special 13-channel, multi-conductor, two-cable assemblies, specifying and manufacturing a large, hydraulically-operated "A" frame with special shock absorption, and a special towing winch, as well as providing the sensor calibration services.

Fishtank Light-Control System

In support of CCIW biological studies, a transportable, autoprogrammed fluorescent light-dimming system was developed and tested successfully. This unit simulates the natural light cycles, required for certain biological studies. Similar units are being manufactured by a Canadian industry now for some of our other light sensitive environmental projects.

Sediment Settling-Tube Pressure-Recording Facility

Two such systems for monitoring sediment settling characteristics were investigated, designed, installed and calibrated for geolimnology work during 1972. These systems are unique in that the extremely small (submillimetre) differential pressure-heads involved require an unusually sensitive and stable transducing system.

C-14 Incubator

Following a successful year with a C-14 incubator aboard the Martin Karlsen, a revised version has now been completed for laboratory use; see Figure 53. This new apparatus will be used to determine the effects of nutrients and toxic materials upon different algal cultures or upon the biota in lake water. The samples are first innoculated with carbon 14-labelled sodium carbonate and then exposed to high intensity fluorescent light for several hours, filtered, and the collected residue is measured for take up of carbon 14 by means of a liquid scintillation counter.

The new C-14 incubator consists of a slowly rotating disc to which are attached the sealed sample bottles. The disc stands in a bath of continuously re-circulating freshwater which is temperature controlled to within +0.5°C, while exposed to high intensity fluorescent lights.

Support to Water Quality Branch

During 1972 engineering support was provided to Water Quality Branch, Ottawa in respect of network telemetry conversion methods; water quality network teleprinter problems; dissolved-oxygen recording systems; and auto-analyzer/printout facilities. Reviews commenced late 1972 into such aspects as sensor technology, data-acquisition and formatting, and platform selection, aimed at establishing areas where effective contributions can best be made.

Maintenance, Repair and Calibration of Instrument Inventory

As in previous years, a large portion of our support to research programs at CCIW was in the form of maintenance of the substantial amount of instruments and equipment, totalling more than 1,000 items. This inventory, which is effectively common-user in application, now comprises over $1 M in electronic test equipment, and over $1 M in conventional environmental sensing instruments.

To service, maintain, and improve these items, approximately 500 Work Order Requests were actioned, encompassing preventive maintenance, fault diagnosis, detail improvements, and calibration. Approximately $200,000 in maintenance-type contracts were placed with Canadian industry, exclusive of extensive special-spares purchase and provision of an electronic and mechanica

hardware components and stock system for general CCIW use.

Assistance to Hydraulics Division

In the areas not covered by previous contracts, Engineering has assisted the Hydraulics Division by designing and installing large baffle units for the flume header tanks, flow diverters between header tanks and volumetric tanks, and ducting, valves, diffusers, etc. for the 1 meter and 2 meter tilting Flumes. In addition, the complete design of a 104 feet long tilting re-aeration flume was done by Engineering. This flume is a recirculating type with a 60 cm wide trough and is to be used for research into the process of atmospheric re-aeration in open channel flow. It is under contract for manufacture to Canadian industry.

COMPUTER SERVICES

The Computer Services section has the responsibility for planning, implementing and operating the major electronic data processing systems and hardware at CCIW and for providing the Canadian portion of the IFYGL Data Bank. Two units comprise the section: (1) a Computer Applications Unit, which develops and maintains computer software, provides consulting services, provides data management services, and operates the Canadian IFYGL Data Bank, and (2) a Computer Systems Unit, which provides systems software services, and which schedules and operates the hardware computing and keypunch facilities at the Centre.

The Computer Systems Unit operates and maintains a variety of computer systems, the largest being the Control Data 3300, which carries the major load of computing done at CCIW. This system was delivered on January 28, 1972, switched on January 30, 1972 and, after 3 days of testing, the initial version of the Mass Storage Operating System (MSOS) was installed on February 3rd. During February, extensive system software was developed to adapt the operating system to CCIW's requirements. On March 1, the 3300 system became fully available to the user, and has been operating on a 5-day week, with the exception of June 1-5, when the Disk Storage Subsystem was changed.

During 1972, a total of 19,416 jobs were run on the system, which utilized 842.1 computer hours, and required the mounting of 6,686 magnetic tapes. The loading on the machine increased from 1,150 jobs requiring 46.7 hours in March, to 2,390 jobs and 110.0 hours in December.

System software development continued throughout the year and by the end of 1972, 20 successive editions of MSOS had been installed, each containing improvements and/or corrections to the previous editions. In addition, several programs and subprograms, such as a package for programming the CALCOMP plotter, have been made available to the user community.

In addition to the Control Data 3300, the section has a DEC PDP-8 system used to reformat instrumentation data tapes to "computer compatible" magnetic tape. A larger PDP-15 equipped with two magnetic tape drives, disc storage, an interactive graphics system and a CALCOMP drum plotter, is used for special applications such as analog to digital conversion, contour and other displays, data quality control, and experimental programming and processing techniques.

Terminals to off-site computers also were utilized for numerical models and special data management processing. The high-speed and large capacity Control Data 6600 at Multiple Access Ltd., Don Mills, Ontario, was used for these purposes. During the transition period to the on-site 3300 computer system, the Control Data 6400 at McMaster University was used as the major computer, but was phased out completely by July. Teletype terminal services to COMSHARE Ltd. Sigma-7 was available for interactive programming.

For all of the computer systems, a total of 32,200 jobs were run in 1972, up from 16,000 in 1971 (or an increase of 101%). This compares with 9,100 jobs in 1970, 6,800 in 1969, and 1,300 in 1968.

The Computer Applications Unit's responsibilities in detail include: (1) the provision of consultative services to users; (2) the provision of reference facilities to users; (3) the preparation of software on request by scientific and technical staff; (4) to anticipate, and plan future software needs; and (5) to develop software systems used in analysis and large-scale data base management. In addition, the unit has the responsibility for the Canadian International Field Year for the Great Lakes Data Bank, which has a counterpart in the U.S. Federal Government (National Oceanographic and Atmospheric Administration). The latter responsibility entails data management, software development, and development of new systems, methods and procedures.

During the year, a total of 34 projects were carried out, including the IFYGL Data Bank which continued over the whole year, and will continue into 1973. The other projects ranged from a short one of two weeks duration to develop a small analytical program, to one lasting four months dealing with biological-chemical modelling.

The STAR (Storage and Retrieval) software system for handling shipboard data was updated, as was the TSAR (Time Series Storage and Retrieval); both of these systems being developed in 1971. Analytical programs for standard statistical and time series analysis were developed, or modified, and are a continuing project. The major single thrust of software systems development occurred for the Canadian IFYGL Data Bank, where programs and systems were designed and developed to convert, reformat, file, and retrieve IFYGL data, which will comprise about 400-500 million characters of information.

LIBRARY

The collection consists of 9,000 books, 900 journals and related abstracting services, and 250 report series. A computer index to these reports is available and includes all those received up to the end of this year. During the year, 51 translations were made for CCIW staff members; 2,170 Inter-Library Loans were obtained; and 470 of our items were loaned to other libraries. It is estimated that an average of 120 persons use our library daily.

Several searches were made of National Research Council's (NRC) computerized data base "Pollution Information Project" to obtain information on such subjects as trace elements, viruses in water and toxic effects of chemicals on aquatic life. In addition, several new computer profiles were submitted to the various data bases in NRC's CAN/SDI current-awareness system.

With the development this year of the WATDOC information retrieval system within Water Management Service, all of CCIW's publications are now included in this system. Likewise they were submitted to the U.S. Water Resources Scientific Information Service for inclusion in *Selected Water Resources Abstracts.*

The library staff continued to produce *Collected Reprints,* acquisition lists and the other listings mentioned in previous annual reports.

TECHNICAL SERVICES

Permanent occupancy of the remaining buildings was completed during the year as staff moved into the first and second floors of the Administration and Laboratory Building in January, the remaining portion of the building was occupied early in May, and the Hydraulics Laboratory and offices were occupied in August.

All phases of the construction program are now complete, including outside signage, landscaping, and the removal of the trailer complex; the trailers were sent to various locations in Canada, such as Vancouver, Halifax, Ottawa and Sault Ste. Marie for use by other staff of our Department.

Other support services such as drafting and illustrating, security and maintenance of the buildings and property were supplied throughout the year, and a good start has been made on setting up a common-user stores system for the Centre.

Public Relations and Information Services

Public relations may appear to some an unlikely ctivity to associate with government-sponsored scientific esearch in an institution such as the Canada Centre for nland Waters. In fact, however, relating the Centre's work nd achievements to the taxpaying public and relating that ublic and its concern back to the management of the Centre is as vital a process as the research and surveys onducted there.

In 1972, the general public and the news media ontinued to demonstrate the truth of this. Following the Centre's Open House invitation in May, a total of more han 13,400 visitors came during the year to the CCIW to ear about the problems of modern fresh water management and the Centre's contributions to the growing fund of cientific knowledge of the subject. The Centre's official pening by the Minister was widely covered by both press nd broadcast media. Throughout the year, newspapers, nagazines, radio and television stations willingly accepted r sought invitations to news briefings, conferences and nterviews so as to expose the latest findings of our cientists, surveyors and engineers.

With an Information Officer added to the staff and urther augmented by student helpers during the summer, he Public Relations Unit considerably improved its apacity to meet this demand with proper response and to enerate initiatives of its own.

A major challenge was the organization of the official pening of the Centre in May. Hard work and a team spirit nabled this small group to arrange effectively the hundreds f details inherent in such an occasion and to still xperience the satisfaction and excitement which made it emorable.

Another auspicious occasion in which the Unit was eeply involved was the official opening of the International Field Year for the Great Lakes. This event was one hich nearly turned out to be too memorable as a playfully gusty wind from Hamilton Bay tried several times to carry a symbolic weather balloon together with its hard-pressed anchor man aloft, prior to the ceremonial moment.

The Okanagan Basin Study, perhaps the finest example yet of democratic public involvement in water management decision-making, was also a project in which CCIW scientists made significant contributions. The Centre's Public Relations Officer was asked to assist and spent several weeks in Vancouver and the Okanagan helping with the public involvement aspects.

The year 1972 also saw the inauguration of the annual CCIW Science Cruise Awards. Arranged in conjunction with the Hamilton Spectator and McMaster University, this award consisting of a cruise of several days duration aboard one of the major research vessels based at CCIW were presented to six students from the Burlington/Hamilton area who had made prize-winning contributions to the annual Hamilton Science Fair.

A permanent exhibit was designed, built and installed at the Centre to become the focal point for visiting members of the public. To this was added a demonstration laboratory which by year's end was well on the way to completion.

Another innovation was the creation of CCIW News-Notes - brief, informative descriptions of new scientific undertakings at the Centre - sent to a list of nearly 100 scientific and technical publications in North America and Europe.

Finally, the Centre's public relations programme included a series of over 50 outside speaking engagements. Scientists, engineers and staff of the Public Relations Unit spoke to average audiences of 30 - 40 people reaching a year-end total of more than 2,300 interested listeners whose invitations to us had been prompted by their interest in, and concern for water.

Environmental Quality Coordination Unit

The Environmental Quality Coordination Unit (EQCU) coordinates the results of research from two or more components of CCIW with research results produced by groups elsewhere, in a form designed to assist in the establishment of policies and action programs of the Department of the Environment and other water management agencies in Canada. EQCU assists in the dissemination of research results to water management agencies in Canada in a form which may be readily converted to action programs and public policies by these agencies. In addition, EQCU provided technical input to a national contingency plan for fresh water regions; contributed to the development of the Canada-U.S. Agreement on Great Lakes Water Quality, and to the subsequent International Joint Commission activities called for under the Agreement.

EQCU continued its active role on contingency plans for combatting oil and other toxic material spills, both in the Great Lakes region and internationally. The Unit provided liaison for the Ontario Contingency Plan Coordinating Committee, provided the Chairman for the Technical Working Group of the Federal Contingency Plan, the Chairman for the CCIW Task Force on Spills of Oil and other Toxic Materials, and represented CCIW as a member of the local Hamilton Harbour Spill Control Group. These activities were assumed by the Environmental Protection Service in the latter part of the year.

The problem of nutrient control, and particularly the substitution of phosphates in laundry detergents continued to be an active topic for much of the year. Continuing coordination was provided by EQCU for the research program associated with these substitutes. In March a major meeting was called to review the results at that time of the various governmental and private sector research programs including the Canadian monitoring program for NTA in the environment. This meeting included representatives from the detergent manufacturing and related industries, and Canadian and United States government agencies. On the basis of this information which included the completion of most of the in-house programs as well as the successful completion of a monitoring program for NTA in the environment, a position paper was prepared. The decision was later taken by the Minister to decrease further the phosphorus content of detergents to 5% (as P_2O_5) beginning January 1, 1973, and to continue monitoring NTA and other detergent phosphate substitutes and their environmental effects.

As a result a plan was prepared for a national, large scale, monitoring program for detergent phosphorus substitutes and other substances, and is an extension of the previous environmental NTA program, but with the addition of samples from drinking water supplies. Input was provided to this program from industry and government personnel and implementation was initiated late in November. The operational portion of this program is now the responsibility of the Water Quality Branch; however, EQCU will continue to assist in the preparation of reports on the levels of NTA and other detergent phosphorus substitutes in the environment and their significance.

EQCU participated in working groups involved in drafting the Canada-U.S. Agreement on Water Quality in the Great Lakes in support of the Canadian negotiating team. This landmark Agreement was signed on April 15 of this year. The Unit coordinated the preparation of a major report which provided the basis for the phosphorus load reductions to Lakes Erie and Ontario required by the Agreement. In addition, a brief report was prepared assessing the adequacy of proposed U.S. programs in general and, more specifically, the adequacy of the total phosphorus control program in the Lake Erie Basin to reduce the eutrophication problem and to meet the IJC Report recommendations. Additional activities concerned the preparation of press briefings and notes about the Agreement, and also the design of a semi-permanent display for the official opening of CCIW which depicts the application of science activities to water management through this international agreement. This display traces the progress of activities which led up to the Agreement including the IJC studies and the Canada-Ontario Agreement on Great Lakes Water Quality.

EQCU was actively involved in the Canadian implementation activities associated with the Agreement, through the provision of support to the Director who was named to the Interdepartmental Committee on Water's Subcommittee concerned with implementation, and through participation in the development of submissions to Treasury Board for resources to carry out the various studies and other activities required by the Agreement.

EQCU has, for a number of years, been extensively involved in IJC activities. With the signing of the Great Lakes Water Quality Agreement additional activities were generated with a number of personnel from CCIW and Inland Waters Directorate, Ottawa, being named to the various Boards and Reference Groups which were established. EQCU is providing the technical secretariat for the

Canadian Co-Chairmen of the Great Lakes Water Quality Board, the Research Advisory Board, the Land Drainage Reference Group and the Upper Lakes Reference Group. EQCU staff serve on the Editorial Committee and other working groups of the Great Lakes Water Quality Board.

A report was prepared for the IJC Water Quality Board on Polychlorinated Biphenyls (PCB's) in the Great Lakes environment. The report consolidated information from several U.S. states, the Province of Ontario and the work carried out at CCIW. In addition, a literature survey was completed summarizing information on environmental and health effects and on analytical methodology.

EQCU continued to coordinate the pesticide surveys and organochlorine residue surveys in the Lower Great Lakes during the year. Two additional cruises, one in Lake Ontario and another in Lake Erie were made to obtain plankton samples for PCB and pesticide analysis. An interim report on the pesticide survey which included all available information on PCB's was completed.

EQCU also participated in the activities of the Technical Committee established under the Canada-Ontario Agreement on Great Lakes Water Quality. The principal activities concerned the administration of external research contracts awarded under provisions of this Agreement and the development of suitable publication policies. These policies are designed to ensure that the information produced both by the in-house (Canada and Ontario) and external research activities will be effectively put into practice both by governmental agencies and by the private sector, particularly in the design of wastewater treatment facilities required as a result of the Agreement.

EQCU continued to represent CCIW on a number of interdepartmental committees, carried out a number of international functions pertinent to the work at CCIW, and carried out extensive information programs through the giving of talks and papers at a number of conferences and symposia throughout the year.

CCIW Staff List

CCIW

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Personnel Administration — Miss R. M. Kelly, Mrs. M. Duggan, W. B. Christopher, M. Phillips, Mrs. C. Shepherd, Miss M. R. Warren

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J. Marsalek — waves, combined sewers
Dr. C. K. Jonys — sediment
Dr. M. G. Skafel — simulation
Dr. G. Tsang — ice and cold

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Technical Staff — C. Bil, B. Leaney, D. Wagner

Technical Services Unit

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Dr. R. P. Bukata — remote sensing
C. H. Chan — chemistry in the lakes
H. H. Dobson — nutrients and water quality
H. W. MacPhail — electronics, satellite data retransmissio
M. T. Shiomi — atmospheric precipitation chemistry; nu trient cycles in large lakes
Dr. B. E. St. John — trace element geochemistry
Dr. K. P. B. Thomson — remote sensing
Support Staff — G. Bengert, R. Chapil, F. Chiocchio, K Kuntz, W. McColl, D. St. Jacques

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Geolimnology Section

Head — Dr. R. L. Thomas — distribution, occurrence ar anthogenesis of minerals, major elements and heavy meta

in recent sediments
Dr. T. W. Anderson (GSC) — Palynology of recent sediments
J. P. Coakley — distribution, occurrence and relation to erosion, transportation and deposition of active sediments
Dr. C. I. Dell — stratigraphic correlation and mineralogy, including clay mineralogy, of recent sedimentary sequences
J. B. Henry — geophysical characteristics of unconsolidated sediments
Dr. N. A. Rukavina — interpretation of sediment distributions in the nearshore area
W. Warwick (educational leave) — palaeo ecological interpretation of chironomid fauna
Dr. C. F. M. Lewis (recalled to GSC Ottawa) — post-glacial uplift and stratigraphic correlation of recent sediments
Technical Staff — W. Booth, G. Duncan, J. Horseman (GSC), G. LaHaie, Mrs. L. Mansey, T. Morton, R. Sandilands

Physical Limnology Section

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Dr. J. O. Nriagu — stable isotopes of sulfur; stabilities of authigenic minerals
Dr. R. R. Weiler — CO_2: air/lake interactions; sedimentary geochemistry
Dr. J. D. H. Williams — sediment/water interface exchange, geochemical processes in sediments
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Dr. P. T. S. Wong — degradation of new substances by bacteria
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H. R. van Otterloo — Great Lakes studies
A. S. Menon — field bacteriologist, paper mill studies
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G. Wade — polar continental shelf project
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Richards — U.S. Lake Survey
/. Bergen — U.S. Exchange

C.S.S. "Parizeau"

Statham

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Engineering Superintendent — A. T. Hughes
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Shop Foreman — K. D. Robertson
Shop Staff — J. Allan, J. Boyle, J. Fasullo, V. Rahelic, J. Wright, M. Thomson

C.S.S. "Limnos"

Captain — N. L. Keeping
Officers — M. C. Birchall, J. A. Butler, T. C. Kenney, G. Sproule, J. Stansfield (10 Ships Crew)

C.S.S. "Advent"

Officers — R. R. Charles (3 Ships Crew)

Launches

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Hydrographic Surveys — 76 Seasonal Ships Crew

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A/Administrative Officer — B. J. T. O'Hagan
Office Manager — J. R. Dobson
Accounts — A. B. Mitchell
Stores — E. R. Gibbons
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Secretary — Mrs. A. O'Hara

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Secretary — Miss L. Sully
Administration Unit — Mrs. J. Guenther

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T. Pang — electron microscopy
Radiochemistry Technologists — R. J. Goble, C. Scutt

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Technologists — J. A. Diaz, D. Fekyt, A. Fletcher, J. G. M. Larocque, K. Mollon, M. Pedrosa, J. A. Tyler
Mechanical Engineering — A. E. Pashley
Mechanical Engineers — B. P. Brady, P. M. Ward-Whate
Technologists — R. Boucher, J. Heidt, H. Savile
Tradesmen — R. V. Chumley, K. K. P. Kalter, D. H. Whyte

Computer Services

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Computer Systems — H. C. Pulley
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Computer Application — Dr. H. S. Weiler
Programmers — G. S. Beal, Mrs. H. E. Comba, Miss J. E. Dowell, B. Hanson, Miss B. Pyde
Data Preparation and Publication — W. Nagel
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Support Staff — F. Kushner, Mrs. B. Titley, T. A. Williams
Warehouse — A. W. Mayes
Support Staff — D. Henneberry, R. J. Haswell
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PUBLIC RELATIONS AND INFORMATION SERVICES

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Secretary — Mrs. I. Powell
Information Officer — D. M. Canning
Assistant — Mrs. J. Bracewell

ENVIRONMENTAL QUALITY COORDINATION UNIT

Head — Dr. A. R. LeFeuvre
Secretary — Mrs. H. Hetherington
Assistant — J. W. Schmidt
Scientific Officer — G. F. Gabriel

APPENDIX B

Publications and Presentations

PUBLISHED PAPERS

Afghan, B.K., P.D. Goulden and J.F. Ryan. Automated method for determination of nitrilotriacetic acid in natural water detergents and sewage samples. Analytical Chemistry, *44,* 354 (1972).

Afghan, B.K., P.D. Goulden and J.F. Ryan. Automated fluorometric method for determination of boron in waters, detergents and sewage effluents. Water Research, *6*, 1475 (1972).

Afghan, B.K. and P.D. Goulden. Twin-cell oscillographic DC polarography for the analysis of trace metals. Canadian Res. & Develop., July-August, 1972.

Bell, J.B. and B.J. Dutka. Microbiological examination of Lake Ontario sediments. I. Distribution of aerobic and anaerobic heterotrophs in several Lake Ontario sediments. Proc. 15th Conf. Great Lakes Res., Int. Assoc. Great Lakes Res., pp. 1-8, 1972.

Bell, J.B. and B.J. Dutka. Microbiological examination of Lake Ontario sediments. II. Heterotroph methodology comparison. Proc. 15th Conf. Great Lakes Res., Int. Assoc. Great Lakes Res., pp 9-14, 1972.

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Boyce, F.M. 1972. The thermal structure and heat content of Lake Ontario, preliminary results. International Field Year for the Great Lakes Bulletin Number 4, p. 34.

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Brewer, A.A., and *K.P.B. Thomson.* A radiometer-sonde for observing stratospheric emission due to water vapor in its rotational band, Quart. J. R. Met. Soc., *98,* pp. 187-191.

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*Based on work done before joining CCIW.
Where a paper was prepared jointly by a CCIW author and an author from another organization, the name of the CCIW author is shown in italics.

Bruce, J.P. 1972. Meteorological aspects of Great Lakes pollution. WMO Special Environmental Report No. 2, Selected Papers on Meteorology as related to the Human Environment.

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Burns, N.M. and C. Ross. Oxygen-nutrient relationships within the central basin of Lake Erie. Nutrients in Natural Waters, eds. H. E. Allen and J. R. Kramer, Wiley-Interscience, N.Y., pp 193-249

Chau, A.S.Y. Confirmation of pesticide residue identity. Derivative formation for the conformation of photo-products of endrin: hexachloro and pentachloro-ketone pesticide residues by Gas Chromatography. J. Ass. Off. Anal. Chem. *55*, pp 519-525.

Chau, A.S.Y. and M. Lanouette. Confirmation of pesticide residue identity. II. Derivative formation in solid matrix for the conformation of DDT, DDD, methoxychlor, perthane, *CIS*—and Trans-chlordane, heptachlor, and heptachlor epoxide pesticide residues by Gas Chromatography. J. Ass. Off. Anal. Chem. *55*, pp 1058-1066.

Chau, A.S.Y. Confirmation of pesticide residue identity. III. Derivative formation in solid matrix for the confirmation of endrin by Gas Chromatography. Bull-Environ. Contam. Toxicol. *8,* pp 169-176.

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Freeman, N. and T.S. Murty. A study of the storm surge on Lake Huron. Proc. 15th Conf. Great Lakes Res., 1972.

Gilbertson, M., H. H. Dobson and T. R. Lee. Phosphorus and hypolimnial dissolved oxygen in Lake Erie, pp 141-145 in Project Hypo report, Canada Centre for Inland Waters, CCIW Paper No. 6. 1972.

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No. 1, Lake Huron/Lake Superior. Lake Huron, Cruise 69-202, Sept. 22-29; Cruise 69-203, Nov. 18-Dec. 6 Lake Superior, Cruise 69-302, Nov. 12-25. (1969)

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AWARDS

At the 1972 International Association for Great Lakes Research Conference in Madison, Wisconsin, a new prize called the Chandler-Misener Award was given to H. Dobson and M. Gilbertson for their 1971 paper "Oxygen depletion in the hypolimnion of the central basin of Lake Erie, 1929 to 1970". The award was given for the best paper of the 1971 Conference Proceedings.

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Research and Development Contracts 1972

To provide estimates of the current use of potentially environmentally harmful substances in Ontario industry. (P. D. Fenwick—$3,990).

To conduct the analysis of mercury content of surface sediments from lakes and rivers in Canada. (Barringer Research Ltd.—$5,000).

An investigation of the forms of occurrence of toxic trace metals in river and lake bottom sediments. (Barringer Research Ltd.—$5,000).

To carry out studies of turbulent diffusion in relation to environmental conditions. (Dr. G. Kullenberg, University of Copenhagen—$9,000).

To provide continuing research on a project involving the geological study of the nearshore environment of Lake Superior. (Lakehead University—$10,000).

Advise on lakes research needed to determine water quality criteria with respect to potentially polluting substances. (Mr. D. Matheson—$8,000).

To prepare samples and measure isotopic ratios of sulphur. (McMaster University, Prof. C. E. Rees—$7,970).

To provide for services covering "Radiation Analysis" of data from IFYGL. (McMaster University—$10,750).

An investigation into the feasibility of detecting and quantitatively estimating phosphate minerals in lacustrine sediments by mineralogical methods. (New Brunswick Research and Productivity Council, Dr. D. Abbott—$4,000).

Palynological (pollen) analysis. (Royal Ontario Museum, Dr. J. McAndrews—$2,500).

To identify 1500 Coliform isolates collected from the Rainy River study. (University of Toronto, Prof. P. L. Seyfried—$4,600).

To conduct limnology study as part of IFYGL (University of Toronto, Prof. G. K. Rodgers—$14,666).

To conduct Great Lakes Monitoring program using the Port Dauphine. (University of Toronto, Dr. A. D. Misener—$40,000).

To conduct Coastal Chain studies. (Waterloo Research Institute, University of Waterloo, Dr. G. T. Csanady—$45,000).

Composition of surface sediments of Lakes Ontario, Erie and Huron. (Scintrex Ltd.—$2,500).

Develop and manufacture two prototype and nine production fixed/towed temperature profiling electrical cables. (Boston Insulated Wire, Hamilton—$26,000).

Repair, overhaul, modifications, special investigations and technical studies of existing instrumentation; e.g., current meters, met. packs, etc. (Canadian General Electric, Weston—$150,000).

Manufacture and test prototype expanded Multiple Digital Input Recorder System. (EDA Electronics, Ottawa—$4,400).

Manufacture and test ten monitor printout units (for Plessey Instruments). (EDA Electronics, Ottawa—$19,000).

Develop and manufacture four prototype, seventy-nine production, solid state timers for Plessey Instruments (EDA Electronics, Ottawa—$23,000).

Manufacture and test 10 Dyna-Grip termination assemblies including cable for EBT systems. (Preformed Line Products, Cleveland, Ohio—$15,000).

To provide software for conversion of EROS data retrieval system from 6600 to 31000 computer. (Entropy Systems, Vancouver—$1,500).

The following contracts from headquarters funds were monitored by CCIW staff.

Efficiency and cost of dredging procedures in the removal of polluted fine-grained sediments. (H. G. Acres Consultants Ltd., Niagara Falls—$39,500).

Environmental Distribution of Agricultural Chemicals (Canadian Canners Ltd., Burlington—$35,700).

The use of plastic-media trickling filters for waste water treatment. (Industrial Research Institute, University of Waterloo—$60,000).

To determine the effect of phosphorus limit on the washing efficiency of detergents. (Ontario Research Foundation—$30,988).

Analytical techniques and methodology for polycyclic aromatic hydrocarbons. (University of Calgary, Dr. G. W. Hodgson–$21,468).

Lake Huron–St. Clair critical coastal interface study. (University of Western Ontario, Prof. E. G. Pleva–$9,000).

Application of satellite imagery to water mass delineation of western Lake Ontario. (University of Toronto–$2,983).

Application of ERTS imagery to the study of the ice regime on Lake Erie and the reservoir areas above the Churchill Falls power development in Labrador. (ACRES–$3,500).

Application of satellite data to freeze-up, break-up and changing configuration of Lakes in Northern Quebec and Labrador. (McGill University–$9,210).

Application of satellite imagery to the study of the St. Lawrence Valley area in particular Lake St. Louis and Lake St. Pierre. (CENTREAU, Université Laval–$12,868).

Application of satellite imagery to the study of Big Quill Lake. (Sask. Research Council–$23,560).

Application of satellite imagery to the inventory of the surface and groundwater patterns in the Cooking Lake and Gull Lake Basins in Alberta, Canada. (University of Alberta–$3,209).

Design, assembly and testing of transmitter-receiver system. Conduct propagation and scattering studies at CCIW to determine feasibility of the system as a workable water lidar. (York University–$23,600).

The following contracts were let by CCIW and funded under the Canada-Ontario Agreement on Great Lakes Water Quality.

An Examination of Sewage and Sewage Sludge for Enteroviruses. (Central Public Health Lab.–$9,000).

Solidification of Phosphate Sludges using Industrial Sulfate Wastes and Thermal Power Plant Fly Ash. (Acres Consulting Services Ltd.–$7,500).

Heavy Metals in Agricultural Lands Receiving Chemical Sewage Sludges. (University of Toronto–$15,000).

Aerobic Digestion of Organic Sludges Containing Inorganic Phosphorus Precipitates. (University of Toronto–$10,000).

Wet Oxidation of Chemical Sludges. (Waterloo Research Institute, University of Waterloo–$8,000).

The Assessment of Polymers as Aids to the Removal of Phosphorus from Wastewater. (McMaster University–$13,000).

Design and Performance Criteria for Settling Tanks for the Removal of Physical-Chemical Flocs. (University of Toronto–$16,000).

The use of Lime in the Treatment of Municipal Wastewaters. (Domtar Limited–$15,000).

Integration of Physio-Chemical and Biological Wastewater Treatment Processes. (Water Research Institute, University of Waterloo–$21,450).

To Establish Viable Methods of Maintaining Waste Treatment Facility Efficiencies with Reference to Waste Variations. (James F. MacLaren Limited–$13,000).

Chemical Dosage Control for Phosphorus Removal. (Pollutech Pollution Advisory Services Ltd.–$25,000).

Nutrient Control in Sewage Lagoons. (Pollutech Pollution Advisory Services Ltd.–$10,000).

The Effect of Household Sanitary Systems on Urban Watershed Phosphate Levels. (Industrial Research Institute of the University of Windsor–$9,680).

Nitrogen Removal from Municipal Wastewaters. (Dupont of Canada Limited–$30,000).

The Removal of Nutrients by Partial Ozonation followed by Coagulation. (University of Sherbrooke–$7,000).

Land Disposal of Sewage Sludges. (University of Guelph–$50,000).

Characterization of the Behaviour of Chemically-Precipitated Sludges in Soils. (Soil Research Institute, Canada Dept. of Agriculture–$8,000).

CANADA CENTRE FOR INLAND WATERS,
BURLINGTON, ONTARIO, 1973.

Environment Canada

Environnement Canada

Canada Centre for Inland Waters

1973

CANADA CENTRE FOR INLAND WATERS – 1973

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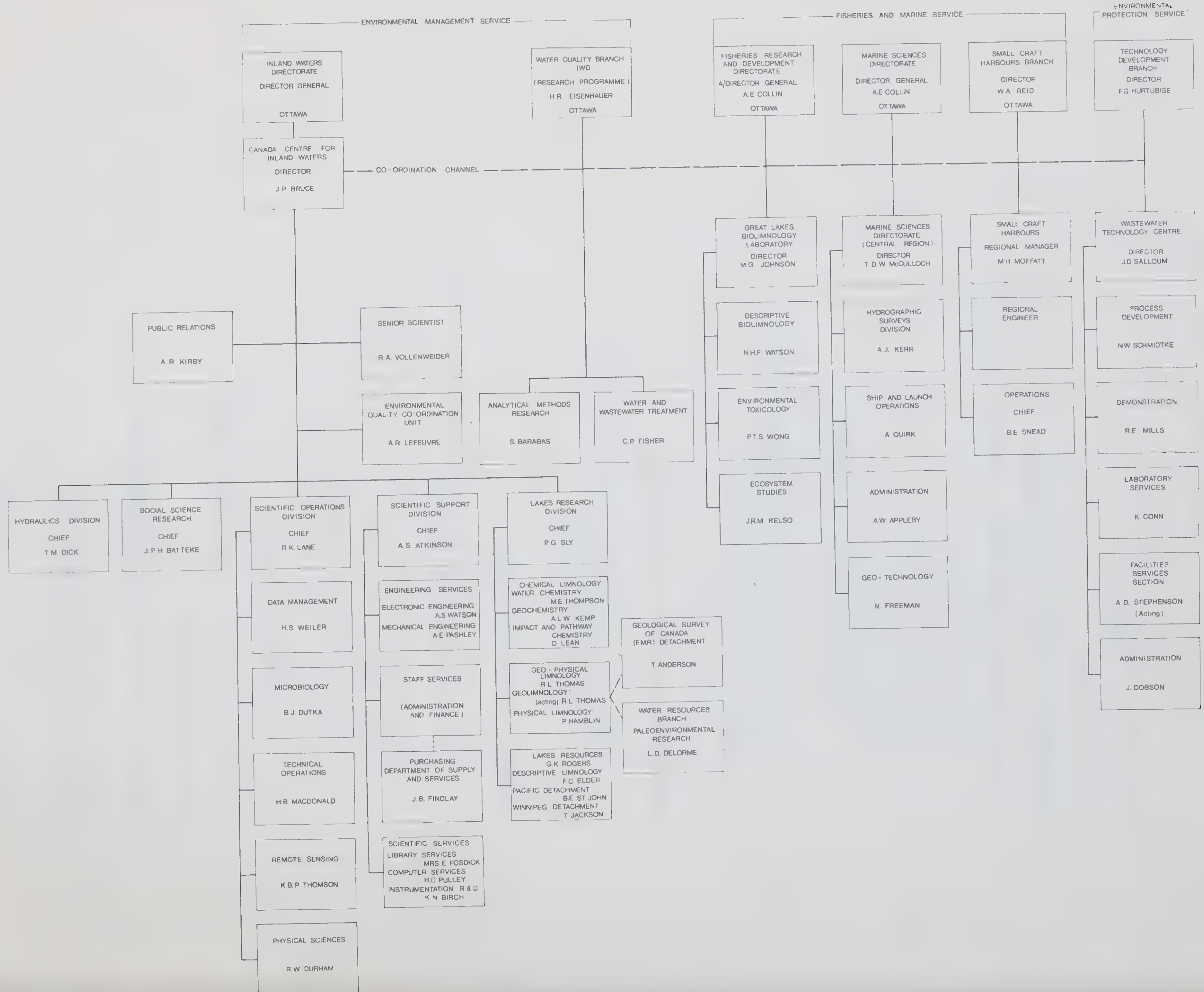
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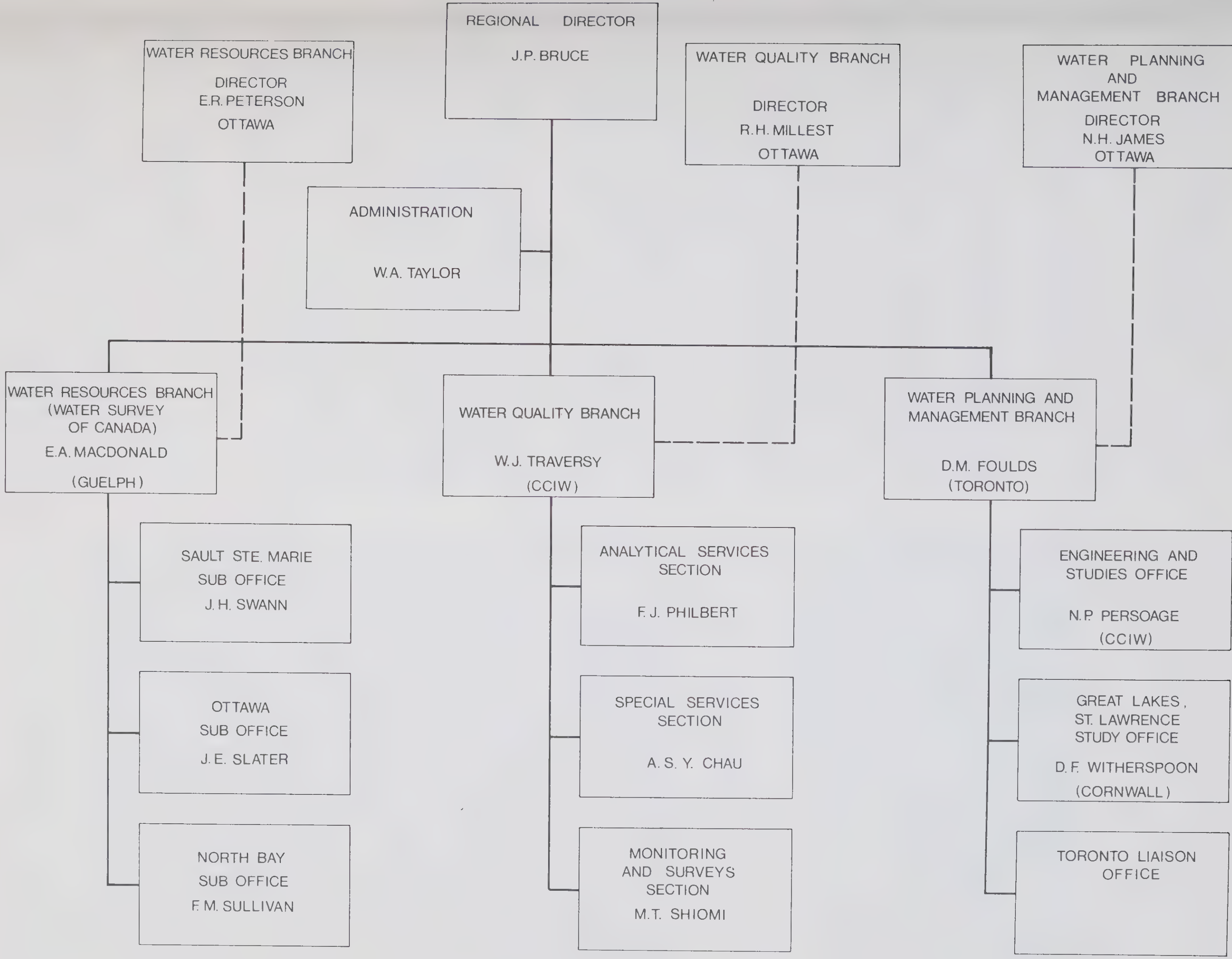


Inland Waters Directorate, Ontario Region, December 31, 1973.

ighlights in Review

IMPLEMENTATION OF GREAT LAKES WATER QUALITY AGREEMENT

A major share of activities were directed towards plementation of programs required by the Canada-U.S. reement signed in 1972. More than a score of staff mbers participated in work of IJC Boards, Committees d Reference Groups established under the Agreement. ecific major research and monitoring projects undertaken started in 1973 included:

(1) Lake Superior base-line water and sediment data collection through 8 major ship cruises,
(2) initial evaluation in Lake Superior of impact and dispersal of a major industrial effluent source (from a pulp and paper mill),
(3) surveillance programs of Lower Great Lakes and interconnecting channels, jointly with Ontario and U.S. agencies, to assess impact of major pollution control measures now being implemented,
(4) initial assessment of priorities and plans to control pollution from land drainage sources, based on available knowledge, and design of definitive study program,
(5) development of research program (mainly by contract) on methods of minimizing environmental impact of disposal of polluted dredged sediments,
(6) physical, chemical and biological projects undertaken to provide a sound scientific basis for water quality objectives for waste heat and radioactivity, and for some of the toxic substances listed in the Agreement, and
(7) special studies of distribution and sources of asbestos-like fibres in Lake Superior water and sediments, in view of the public health concern raised over the high concentrations observed in the Duluth area.

ANADA-ONTARIO AGREEMENT ON GREAT LAKES WATER QUALITY

This domestic Agreement, designed to ensure that nada meets its municipal waste treatment obligations der the international water quality Agreement, also quired substantial efforts of CCIW staff members for ard and Committee activities. It involved EPS, Water ality Branch, and Hydraulics Lab staff in research ojects designed to minimize costs and improve efficiency the estimated $500 million Canadian sewage treatment ogram. The year saw completion of most of the studies on phosphorus removal techniques done by contractors, by Ontario MOE and by EPS at CCIW. The most valuable results were presented at two phosphorus removal design seminars, the first for consulting engineers who are designing the facilities required to be completed under the international Agreement between 1973 and 1975. The second was specifically for municipal officials to give them background information on the need for the program, the technical methods available, and the likely costs. Both in-house and contracted programs under this Agreement are now being concentrated on land disposal of sewage sludges and on methods for reducing pollution from storm and combined sewer systems.

HIGH WATER ON THE GREAT LAKES

High water in the Great Lakes system and related shore erosion problems involved intensive efforts on the part of Inland Waters and Marine Sciences staff. Lake Ontario was close to record levels in the spring, and Erie, St. Clair, and Huron all equalled or exceeded previous highest levels in the past 100 years. Severe spring storms caused extensive flooding and erosion damage. At a major press briefing held at the Centre on March 15th, 2 new pamphlets were released ("What You Always Wanted to Know About Great Lakes Levels — and Didn't Know Whom to Ask" and "Shore Erosion — Cause and Cure") and 2 new Environment Canada prediction services announced, 6-month lake level forecasts and a storm surge advisory service by Atmospheric Environment Service.

IWD Regional staff at Cornwall and CCIW continued to provide extensive technical support to IJC Boards of Control for Lake Ontario and Lake Superior to ensure that discharges from these lakes were made in a way that would minimize shore property damage and other economic losses. A new operating plan was developed for Lake Superior and recommended to Canada and the U.S.A. by IJC. The International Great Lakes Levels Board study for the IJC, initiated in 1964, of the feasibility of greater control of levels, was largely completed at year end. Some aspects of the study will require further work and take into account implications of record high water supplies in 1973.

SHORE PROPERTY DAMAGE — GREAT LAKES

Because of extensive property damage due to shore erosion and flooding, a rapid intensification of shore property surveys and shore erosion studies was undertaken

by MSD and IWD staff at CCIW. In response to requests from the Minister's office, a report was prepared on CCIW work on the past 4 years on this subject. This report was tabled in the House of Commons, March 23rd. In addition, an inter-departmental task force was formed (co-ordination by CCIW) which produced a report summarizing available data on shore erosion and flooding in the whole Great Lakes – St. Lawrence System. At the same time, agreement was reached with the Ontario Ministry of Natural Resources for a special intensive survey of 1973 shore property damage, uses and ownership, erosion rates, and erosion and flood protection needs. CCIW efforts of MSD and IWD, and Department of Public Works activities on this joint $700,000 program with Ontario, are coordinated by a federal task force led by T.D.W. McCulloch, Regional Director, MSD. Federal-provincial liaison is the responsibility of J.P. Bruce, CCIW, and W.A. Giles, OMNR. A major report and Coastal Zone Atlas will be completed by mid-1974.

MAJOR FIELD PROJECTS

Hydrographic Surveys – Arctic

Hydrographic Surveys in the Arctic were emphasized. The Ministry of Transport light icebreaker "NARWHAL" was again used in James Bay, completing the navigable corridor into Fort George. CCGS "N.B. MACLEAN" was also used for a short reconnaissance survey in Chesterfield Inlet. Farther north, the Polar Shelf Project team surveyed Norwegian Bay and hydrographers from Central Region participated in two icebreaker probes aboard "JOHN A. MACDONALD" to Victoria Strait and "LOUIS ST. LAURENT" to the Ringnes Islands.

Hydrographic Surveys – Lake Winnipeg

A major hydrographic survey of Lake Winnipeg, which is planned to extend over five years, was initiated. This survey used a Mini-fix positioning system and Bertram launches.

Research and Development – Marine Sciences Directorate

A pilot project for a major tidal current study in the lower St. Lawrence was carried out by the Research and Development Division using C.C.G.S. "PORTE DAUPHINE". Summer and winter physical oceanographic measurements were undertaken in James Bay in support of an oceanic impact assessment of the James Bay Power Development. Scientific contracts were let: (1) to develop operational techniques for storm surge forecasting on the Great Lakes and (2) to analyze and interpret the physical oceanographic measurements on James Bay.

IWD Projects Outside Great Lakes Basin

Establishment of a Pacific Region detachment based in Vancouver resulted in special studies of sediments and geochemistry of Babine Lake and development of a regional limnology program for British Columbia lakes. Steps were taken to strengthen the Western Region detachment based at the Freshwater Institute, Winnipeg. Staff participated in planning for a federal-provincial study of Lake Winnipeg. In addition, staff from Burlington undertook special projects on Lake Memphremagog, Quebec, on hydraulic design of major culverts on the Mackenzie Highway to minimize hazards to fish movement, and on evaluation of sonic measurements for bed gravel transport measurements on the Vedder River, B.C.

EPS Wastewater Treatment Technology Development

Field projects continued on mine wastes in New Brunswick and land disposal of sludge in British Columbia as well as a number of projects in Ontario.

HYDRAULIC LABORATORY DEVELOPMENT

The new national towing tank facility for calibration of current meters was commissioned in March to replace the former outdoor facility in Calgary. More than 400 meters of 20 different types have now been calibrated. Sediment flumes and cold room facilities for ice hydraulics have been completed, and the major wind/wave flume will be completed early in 1974. Projects on reaeration of streams, waste heat diffusion in rivers and lakes, and combined and storm sewer sampling techniques for mathematical modelling of urban flows and water quality were carried out.

FISHERIES PROGRAM COORDINATION

Strategic planning meetings between Fisheries and Marine Service personnel and Fisheries Management and Research managers of Ontario Ministry of Natural Resources, together with closer working relationships between OMNR field stations and GLBL staff, should lead to a well-coordinated fisheries program on the Great Lakes.

TOXIC SUBSTANCE RESEARCH

IWD and FRD components of CCIW further develop their capability for a comprehensive program of research environmental contaminants. The program ranges fro assessments of uses of toxic materials in the Canadi economy and the social costs associated with these us chemical analytical methods development, research pathways and behaviour of such substances by themsel and in combination, and effects of toxic substances biotic communities. Among important developments were better understanding of the role of natural chelati substances in water systems, demonstration of the meth ation of lead to highly toxic forms in the environment, a a more complete knowledge of the compounds identified PCB's in water, sediments, and fish (see page 1, item

RESEARCH REPORTS AND CONFERENCES

About 120 papers by CCIW staff were published in rnals and departmental publications during the year ppendix B). For the second year in a row a CCIW staff mber won the Chandler-Misener Award for the best per published in the proceedings of the International sociation for Great Lakes Research. This year's winner s Dr. T.J. Simons for his work on mathematical delling of lake circulation. Staff scientists also presented 6 papers at a number of international and national nferences (Appendix B). Three major conferences were d at CCIW with a total attendance of over 1000. The nerican Water Resources Associates Symposium on mote Sensing of Water Resources; the IJC Research visory Board's Symposium on Viruses in the Environ-nt and Their Potential Hazard, and the Chemical titute of Canada's Symposium on Water Quality Para-ters – Their Selection, Measurement, and Monitoring. IW staff also organized a workshop on land drainage ects on water quality held at the University of Guelph.

NEW RESEARCH VESSELS

Two minor research vessels were acquired – DVENT", a fast cutter, 77 feet in length, and ILDUR", 106 feet in length. "HILDUR", which had ginally been built as a research vessel in Norway, was rchased from the estate of the late T.E. Eaton.

OIL SPILL STUDIES

With leadership from the Centre of Spill Technology OST-EPS) at CCIW, programs on oil spill clean-up chnology were accelerated in EPS, F&MS, and IWD. IW staff contributed major portions of new depart-ental guidelines on uses of dispersants and chemical oil rders. Critical evaluation of available remote sensing chniques for spill detection was initiated, and studies of ulsification and mixing of oil in flowing waters carried t. Field evaluations of various clean-up devices, including P (Dynamic Inclined Plane) were carried out.

BAY OF QUINTE PROGRAM

FRD and IWD components conducted an active program the Bay of Quinte in collaboration with Ontario encies. This mostly enclosed bay is, in many ways, as euthrophic as Central Lake Erie, and impact of nutrient control measures being implemented between 1973 and 1975 should be easier to assess than for a large lake. Special "limno corrals" were installed to assess nutrient cycling in such a system, and to permit enrichment experiments to be conducted. Work will continue for several years.

ENGINEERING AND COMPUTER SERVICES

In support of the programs at CCIW in 1973, more than 60 major data-acquisition systems were provided by Engineering Services, which also maintained and calibrated many existing common instruments valued at about $2 million. Although much of this maintenance work is provided under contract by Canadian industry, the administration of the contracts is done by Engineering. An Instrumentation Research and Development unit was started this year, with initial emphasis on developing an underwater monitoring system to measure in situ such parameters as pH, D.O., EH, conductance and light scattering index. A CDC 3170 computer system was installed this year, complete with new "MASTER" operating system, resulting in faster and more complete service to CCIW users.

PUBLIC RELATIONS

One emphasis of 1973's expanded public relations programme was explaining Great Lakes levels fluctuations and regulation efforts. As well as publishing the booklet and folder mentioned on page 1, the Centre began monthly issue of a press release to accompany the new levels forecast service. Production of a short film on this subject was also begun. A film on the Centre and its work was produced, and this became an important part of a new series of monthly public visit programmes which began in the autumn.

INTERNATIONAL INVOLVEMENT

As CCIW programs become better known, the trickle of foreign visitors has become a small torrent. CCIW was designated as lead institute for North American contributions to OECD's measurement program on lake eutrophication, and Senior Scientist R.A. Vollenweider was made chairman of the technical committee for the whole program. Staff members participated in many OECD committees and activities. At the request of the World Health Organization, CCIW has agreed to prepare under contract, an extensive "Guide to Water Quality Management."

Faits Saillants

MISE EN APPLICATION DE L'ACCORD RELATIF A LA QUALITÉ DE L'EAU DES GRANDS LACS

Les efforts ont porté en grande partie sur la mise en application des programmes élaborés dans le cadre de l'Accord signé par le Canada et les États-Unis en 1972. Plus d'une vingtaine de membres du personnel ont participé aux travaux des conseils, comités, et groupes d'étude de la Commission mixte internationale, créés en vertu de cet Accord. Parmi les principaux projets de recherche et de contrôle entrepris en 1973, citons:

1) le recueil de données sur les eaux de surface et les sédiments du lac Supérieur par 8 navires;
2) une première évaluation, pour ce même lac, des effets des effluents provenant d'une source industrielle importante de pollution (en l'occurrence, une usine de pâte à papier), et de leur dispersion;
3) des programmes de surveillance des Grands lacs inférieurs ainsi que des canaux les reliant, en collaboration avec des organismes ontariens et américains, pour évaluer l'efficacité des mesures de lutte contre la pollution actuellement appliquées;
4) une première appréciation des priorités et des plans de lutte contre la pollution provenant du drainage des terrains, sur la base de connaissances déjà acquises, suivie d'un programme définitif d'étude;
5) un programme de recherches (effectuées surtout par contrat) sur les moyens de réduire les effets nuisibles pour l'environnement de l'évacuation par dragage des dépôts pollués;
6) des études physiques, chimiques, et biologiques devant fournir une base scientifique solide pour les objectifs de qualité de l'eau, sur les plans de la chaleur résiduelle et de la radioactivité, ainsi que pour certaines substances toxiques mentionnées dans l'Accord;
7) des études ayant trait à la répartition et à l'origine des fibres de type amiante dans l'eau et les sédiments du lac Superieur, en raison de l'accumulation de ces fibres dans la région de Duluth, accumulation jugée dangereuse pour la santé de la population.

L'ACCORD CANADA-ONTARIO SUR LA QUALITÉ DE L'EAU DES GRANDS LACS

Cet Accord interne, ayant pour but d'assurer la réalisation par le Canada des travaux d'épuration des eaux exigés par l'Accord international, a été à l'ordre du jour de bien des réunions du conseil et des comités du Centre canadien des eaux intérieures (CCIW). La Direction de la qualité de l'eau et le laboratoire d'hydraulique du Service de la protection de l'environnement ont participé aux efforts de réduction des frais et d'amélioration du programme canadien de traitement des eaux d'égout, dont on estime le coût à 500 millions de dollars. La plupart des études sur les techniques d'élimination du phosphore effectuées par des entrepreneurs, par le ministère de l'Environnement de l'Ontario, et par le Service de la Protection de l'environnement du Centre canadien des eaux intérieures ont été achevées cette année. Les résultats les plus intéressants de ces études ont été présentés lors de deux séminaires sur les techniques d'élimination du phosphore; le premier séminaire a réuni les ingénieurs-conseils chargés de concevoir les installations de traitement devant être terminées, en vertu de l'Accord, entre 1973 et 1975. Lors du deuxième séminaire réservé, lui, aux fonctionnaires municipaux, ceux-ci reçurent des renseignements sur la nécessité de ce genre de programme et les méthodes techniques disponibles, et une estimation des frais. Les programmes établis au sein de la direction ou à l'extérieur, en vertu de cet Accord, portent surtout sur l'évacuation sur les terres riveraines des boues résiduelles et sur les méthodes de réduction de la pollution causée par les réseaux d'égouts pluviaux et mixtes.

LES HAUTES EAUX DANS LES GRANDS LACS

Les hautes eaux dans le réseau des Grands Lacs et l'érosion des terres en bordure de ces lacs ont posé bien des problèmes au personnel des eaux intérieures et des sciences de la mer. Le lac Ontario a en effet presque atteint son niveau record au printemps, et les lacs Érié, Saint-Clair, et Huron ont tous atteint ou dépassé leur niveau record du siècle. Au printemps, les violents orages ont provoqué de fortes inondations et une érosion intense du rivage. Lors d'une importante conférence de presse tenue le 15 mars au Centre, on a présenté deux brochures intitulées respectivement: «Ce que vous avez toujours voulu savoir au sujet du niveau de l'eau des Grands Lacs—sans savoir à qui vous adresser» et «L'Érosion des rivages—cause et remède»; deux nouveaux services de prévision(s) d'Environnement Canada ont indiqué les niveaux probables des lacs pour les six mois suivants, et enfin, le Service de l'environnement atmosphérique a prévu les houles sur ces mêmes lacs et donné des conseils à ce sujet.

Le personnel régional de la Direction des eaux intérieures à Cornwall, et le CCIW ont continué d'apporter un concours technique intensif aux conseils de contrôle de la Commission mixte, pour assurer que l'évacuation des effluents des lacs Ontario et Supérieur s'effectue de manière

réduire les dégâts sur les terrains riverains et autres pertes nancières. La Commission a mis sur pied pour le lac upérieur un nouveau programme qu'elle a recommandé ux gouvernements canadien et américain. A la fin de année, l'étude de faisabilité d'un contrôle accru des iveaux des lacs, entreprise en 1964 par le Bureau internaonal du niveau des Grands lacs (IGLLB), pour le compte e la Commission, était terminée en grande partie. Le onseil devra cependant se pencher plus avant sur certains spects de cette étude et tenir compte des niveaux records es Grands lacs en 1973 et de l'afflux d'eau qui en a résulté.

ERRAINS RIVERAINS ENDOMMAGÉS—GRANDS LACS

Devant l'étendue des dégâts dus à l'érosion du rivage et ux inondations, le personnel de la Direction des sciences e la mer et celui de la Direction des eaux intérieures du CIW ont hâté leurs enquêtes sur les terrains riverains ainsi ue les études sur l'érosion des rives. En réponse à la lemande du Ministre, le CCIW a rédigé un rapport sur les ravaux des quatre dernières années dans ce domaine. Ce apport a été déposé aux Communes le 23 mars. Un groupe nterministériel d'étude, dont la coordination est assurée ar le CCIW, a présenté, par ailleurs, un rapport résumant outes les données disponibles sur l'érosion des rives et les nondations dans l'ensemble du réseau Grands lacs — Saint-Laurent. On a convenu, dans le même temps, avec e ministère des Ressources naturelles de l'Ontario, d'entreprendre une enquête spéciale, approfondie, portant sur es dégâts causés en 1973 aux terrains riverains, sur leur emploi et leurs propriétaires, sur les taux d'érosion, ainsi que sur la protection contre l'érosion et les inondations. Les travaux de la Direction des sciences de la mer et de la Direction des eaux intérieures du CCIW, ainsi que ceux du ministère des Travaux publics effectués conjointement avec l'Ontario, dans le cadre de ce programme de $700,000, sont coordonnés par un groupe fédéral d'experts, à la tête duquel se trouve M. T.D.W. McCulloch, directeur régional des sciences de la mer. La liaison entre les gouvernements fédéral et provincial est assurée par M. J.P. Bruce, du CCIW, et M. W.A. Giles pour le ministère des Ressources naturelles de l'Ontario. On présentera, vers le milieu de l'année 1974, un rapport détaillé ainsi qu'un atlas de la zone côtière.

PRINCIPAUX PROJETS

Études hydrographiques dans l'Arctique

Intensification des études hydrographiques dans l'Arctique. Le brise-glace léger «NARWHAL» du ministère des Transports, de nouveau utilisé à la Baie James, a tracé le corridor navigable menant à Fort George. Bref voyage de reconnaissance effectué par le CCGS «N.B. MACLEAN» dans le Chesterfield Inlet. Plus au Nord, l'équipe chargée du projet «Polar Shelf» a parcouru la Baie norvégienne, tandis que des hydrographes de la région centrale participaient à deux trajets de recueil de données, l'un dans le détroit de Victoria, à bord du «JOHN A. MACDONALD», et l'autre vers les îles Ringnes, à bord du «LOUIS ST. LAURENT».

Études hydrographiques du lac Winnipeg

On a entrepris une étude hydrographique poussée du lac Winnipeg, devant durer cinq ans et au cours de laquelle on utilisera le système de positionnement Mini-fix et des chaloupes Bertram.

Recherche et développement—Direction des sciences de la mer

Le personnel de la Division de la recherche et du développement a réalisé un projet-pilote en vue d'une étude poussée des courants dans le bas Saint-Laurent, sur le CCGS «PORTE DAUPHINE». A la Baie James, prise de mesure océanographiques en été et hiver, pour évaluer les effets sur le plan maritime de la mise en valeur de cette région. On a confié par contrat à des organismes (1) l'élaboration de techniques de prévision des houles sur les Grands lacs, et (2) l'analyse et l'interprétation des mesures océanographiques à la Baie James.

Autres projets de la Direction des eaux intérieures

La création d'un service sur la Côte du Pacifique, à Vancouver, a permis d'étudier les sédiments et les aspects géochimiques du lac Babine, et de mettre sur pied un programme de limnologie pour les lacs de Colombie-Britannique. On a, par ailleurs, augmenté le personnel du service de la région de l'Ouest, installé au Freshwater Institute de Winnipeg. Ce service a participé à l'organisation d'une étude fédérale-provinciale du lac Winnipeg. Des spécialistes de Burlington ont, quant à eux, entrepris la réalisation de projets spéciaux concernant le lac Memphremagog, au Québec; la conception, sur le plan hydraulique, de grands ponceaux le long de l'autoroute Mackenzie, pour éviter d'entraver le mouvement des poissons, et l'évaluation des mesures par écho-son qui permettront de mesurer le charriage du gravier dans le lit de la rivière Vedder, en Colombie-Britannique.

MISE AU POINT PAR LE SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT D'UNE TECHNIQUE DE TRAITEMENT DES EAUX USÉES

Les projets de traitement des eaux résiduaires des mines au Nouveau-Brunswick et de décharge des boues sur les terres en Colombie-Britannique, ainsi qu'un certain nombre de projets en Ontario, sont en cours de réalisation.

CRÉATION D'UN LABORATOIRE DE RECHERCHES HYDRAULIQUES

La nouvelle remorque-citerne, qui est utilisée à l'échelle nationale pour le calibrage des compteurs actuels, a été commandée en mars dernier; ce réservoir remplace l'ancienne installation à ciel ouvert de Calgary. Plus de 400 compteurs de 20 modèles différents ont maintenant été calibrés. L'installation de canaux de dépôt et de chambres froides pour les eaux glacées a été achevée, et l'aménage-

ment principal de canaux destinés à l'étude de la vitesse des vents et du mouvement des vagues sera terminé au début de 1974. En outre, certains projets portant sur la réaération des cours d'eau et la diffusion des chaleurs perdues dans les rivières et les lacs ont été mis en œuvre. Il convient également de signaler la mise au point de techniques d'échantillonnage combinées et de techniques d'échantillonnage dans les égouts d'eaux pluviales, qui ont permis d'établir un modèle mathématique de l'évacuation des eaux urbaines et de la qualité de l'eau.

COORDINATION DU PROGRAMME SUR LES PÊCHES

Les réunions de planification stratégique entre le personnel du Service des pêches et des sciences de la mer et les directeurs de la gestion et des recherches sur les pêcheries du ministère ontarien des Ressources naturelles (OMNR), ainsi que les étroites relations de travail qu'ont entretenu les stations de l'OMNR établies sur place et le personnel du GLBL, devraient donner lieu à une coordination efficace du programme relatif à la pêche sur les Grands lacs.

RECHERCHES SUR LES SUBSTANCES TOXIQUES

La Direction générale des eaux intérieures (IWD) et la Direction des recherches sur les pêches (FRD), qui travaillent de concert avec le Centre canadien des eaux intérieures (CCIW), se sont doté des moyens nécessaires pour établir un programme global de recherches sur les contaminants de l'environnement. Le programme porte sur l'utilisation estimative des substances toxiques au niveau de l'économie canadienne et des coûts que cela représente sur le plan social, le perfectionnement des méthodes d'analyse chimique, les recherches sur les déplacements et le comportement de ces substances, considérées isolément ou combinées à d'autres substances, ainsi que les effets des substances toxiques sur les milieux biotiques. Parmi les principaux résultats obtenus jusqu'à présent, citons notamment: une meilleure compréhension des phénomènes que produisent les substances naturelles «chelatantes» dans les réseaux de canalisation, une confirmation que la méthylation du plomb donne liau à un coefficient élevé de toxicité dans l'environnement, ainsi qu'une connaissance plus approfondie des éléments appelés PCB, que l'on retrouve dans l'eau, dans les sédiments et dans l'organisme des poissons (voir page 4, item 5).

RAPPORTS DE RECHERCHES ET CONFÉRENCES

Au cours de l'année, environ 120 rapports préparés par le personnel du CCIW ont été publiés dans les revues et bulletins du Ministère (Annexe B). Pour la deuxième année consécutive, un employé du Centre a remporté le prix Chandler-Misener pour le rapport le plus intéressant paru dans le Journal de l'Association internationale de recherches dans les Grands lacs. Le Prix a été décerné cette année au Dr. T. J. Simons pour ses travaux sur l'établissement d'un modèle mathématique de l'écoulement de l'eau de lacs. Des scientifiques du Centre ont également présent 196 rapports à certaines conférences nationales e internationales (Annexe B). Le CCIW a organisé troi importantes conférences qui ont attiré plus de 100 personnes au total. Il s'agit du American Water Resource Associates Symposium on Remote Sensing of Wate Resources (Symposium américain sur la détection à dis tance des ressources en eau), du Symposium du Consei consultatif de recherche de la Commission mixte inter nationale où il a été question de la présence de virus dan l'environnement et leurs effets nocifs éventuels, et enfin d Symposium du Chemical Institute of Canada sur le paramètres de la qualité des eaux—leur choix, leur mesur et leur contrôle. Le personnel du CCIW a en outre organis un atelier de travail à l'Université de Guelph, où le participants ont analysé les effets du drainage des terres su la qualité de l'eau.

NOUVEAUX NAVIRES DE RECHERCHES

On a fait l'acquisition de deux petits navires de recher che, le «ADVENT» et le «HILDUR», qui mesurent respecti vement 77 et 116 pieds de longueur. Le premier est u cotre de grande vitesse, et le deuxième, qui a été construi en Norvège pour les fonctions qu'il remplit actuellement, été vendu par les héritiers de feu. T. E. Eaton.

ÉTUDES SUR LE DÉVERSEMENT D'HYDROCARBURE

Sous la direction du Centre technologique de détectio des hydrocarbures (COST-EPS) au CCIW, le Service de l protection de l'environnement (EPS), le Service des pêche et des sciences de la mer (F&MS) et la Direction général des eaux intérieures (IWD) ont accéléré la mise en œuvr des programmes sur les techniques d'épuration des eau polluées par les hydrocarbures. Le personnel du CCIW contribué à l'établissement de la plupart des lignes d conduite ministérielles sur l'utilisation des dispersifs et de agents de regroupement chimique des hydrocarbures. Le travaux entrepris comportaient une analyse critique de techniques actuelles de détection à distance des nappe d'hydrocarbures, des études sur l'émulsification et l mélange d'hydrocarbures dans les eaux vives, ainsi que de évaluations sur place des divers dispositifs d'épuration, don le DIP (plan incliné dymamique).

PROGRAMME DE LA BAIE DE QUINTE

De concert avec des organismes ontariens, la Directio des recherches sur les pêches (FRD) et la Direction général des eaux intérieures (IWD) ont entrepris un programme d namique dans la baie de Quinte dont les eaux, presqu entièrement entourées de terres, sont, à plusieurs égard aussi eutrophes que celles de la partie centrale du lac Éri Les dimensions restreintes de la baie, comparativement à l superficie d'un grand lac, devraient permettre d'évaluer pl

ilement l'efficacité des mesures de contrôle au moyen de stances nutritives, mises en œuvre entre 1973 et 1975. s bancs de limnées d'un type particulier ont été déposés ns les eaux, en vue d'analyser le cycle nutritif dans ce ssin, et d'entreprendre des expériences d'enrichissement. s travaux se poursuivront pendant plusieurs années.

SERVICES TECHNIQUES ET INFORMATIQUES

Pour appuyer les programmes mis en œuvre au CCIW en 73, les services techniques ont fourni plus de 60 systèmes ncipaux de prise de données et ont assuré l'entretien et le ibrage d'un grand nombre d'instruments courants, éva- s à plus de 2 millions de dollars. Bien que l'industrie nadienne assure la majeure partie de ces travaux d'entre- n par voie de contrat, l'administration de ces contrats combe aux services techniques. Une unité de recherche et perfectionnement dans le domaine des instruments a été éée cette année, en vue de mettre au point un système de ntrôle sous-marin permettant de mesurer sur place des ramètres tels que le pH, la teneur en oxygène dissous, xydo-réduction, ainsi que les coefficients de conductivité de dispersion de la lumière. Un système d'ordinateurs C 3170, installé cette année et comprenant le nouveau stème d'exploitation «MASTER», permet de dispenser x utilisateurs du CCIW des services plus rapides et plus mplets.

RELATIONS PUBLIQUES

Le programme de relations publiques, dont les cadres ont été élargis cette année, visait entre autres à expliquer les fluctuations de niveaux dans les Grands lacs, ainsi que les efforts déployés en vue de les régulariser. Outre la parution de la brochure et du dépliant mentionnés à la page 4, le Centre a commencé à publier un communiqué mensuel qui vient s'ajouter au nouveau service de prévision des niveaux d'eau. Un court métrage portant sur ce sujet est en voie de réalisation. De plus, un film consacré au Centre et à ses activités a joué un rôle important dans l'organisation de nouveaux programmes de visites publiques mensuelles, qui ont débuté à l'automne.

PARTICIPATION À L'ÉCHELLE INTERNATIONALE

À mesure que les programmes du CCIW deviennent plus connus, le nombre des visiteurs étrangers s'accroît en conséquences, et le Centre a été désigné comme l'institut nord-américain qui a le plus contribué au programme de mesures de l'OCDE sur l'eutrophisation des lacs. Le réputé scientifique R. A. Vollenweider a été nommé président du comité technique pour l'ensemble du programme. Les membres du personnel ont participé aux travaux de plusieurs comités et programmes de l'OCDE. À la demande de l'Organisation mondiale de la santé, le CCIW a consenti à préparer à contrat un ouvrage d'envergure qui s'intitulera «Guide to Water Quality Management» (guide destiné à la gestion de la qualité des eaux).

Environmental Management Service

ıland Waters Directorate — National Research

HYDRAULICS DIVISION

COMMISSION

The Hydraulics Division is responsible for the inception d implementation of a service and research program in draulics which is national in scope.

A national calibration service for hydrometric instru- ents, particularly current meters of all types is provided. her types of testing may also be undertaken. Tests of a libration nature are done to suit the user's specifications.

Research studies and tests are undertaken directly in e Divisional laboratory or indirectly by contract. Subjects study are basic fluid dynamics, mobile boundary draulics, density currents, ice and cold weather hy- aulics, wave dynamics erosion, coastal engineering and ban hydraulics. The aims are to bring about by systematic periments a thorough understanding of natural hy- aulics processes to provide estimates of the changes in gime caused by land and water developments and to seek e most efficacious practices and design methods which ill mitigate undesirable environmental changes.

LABORATORY DEVELOPMENT

A sensibly large portion of the Divisional effort was evoted to the preparation of specifications, supervision of ontractors and expedition of deliveries for the acquisition major equipment in the Hydraulics Laboratory. A citation of the various design decisions, problems, com- romises and crises is not interesting in retrospect but it ay be useful to summarize here the specifications of quipment operating or almost ready by December 1973.

. **Towing Tank and Carriage**

Tank:	Interior length	122 m
	Interior width	5 m
	Interior depth	3 m

Carriage: The carriage is a semi-automatic remote controlled unit installed by Westinghouse Canada Ltd. Speeds are controlled well within the specified limit of ±1% and there are three speed ranges:

0.5 – 6.0 cm/s
5 – 60.0 cm/s
50 – 600.0 cm/s

2. **1m Tilting Flume**

This is a basic flume with glass walls. Maximum discharge is about 0.80/m^3/s. The dimensions are:

Width	1.0 m
Overall length	25.91 m
Wall height	0.76 m
Slope	Infinitely variable from 0 to 5%

3. **2m Flume**

This flume is still undergoing final adjustments. It was designed primarily for sediment research and forms part of an integrated system described below.

Flume: The flume is a steel and aluminum structure with glass walls. Maximum discharge is about 0.80 m^3/s. The dimensions are:

Width	2.0 m
Overall length	22.8 m
Wall height	0.76 m
Slope	Infinitely variable from −1% to +1%

Sediment Feed: This is still under development but consists of a hopper, a supply system and sediment release mechanism. The basic dimensions are:

Hopper storage	9 m^3
Maximum feed rate	3.25 kg/sec (sand)
Accuracy of feed rate	about ±1%

Sediment Traps: Sediment leaving the flume is trapped in three stilling basins which can be elevated to remove and measure sediment. During the experimental set-up period, all sediment may be diverted to two of the traps, leaving the third central trap for the collection of material during the experimental stage. Basic dimensions are as follows:

Number of traps: 3

Overall dimensions of each trap:	Length	10.98 m
	Width	1.52 m
	Height	2.13 m

The useful accumulation of sediment in each trap is about 2.8 m^3 for fine sediment.

Sediment Processing: A miniature granular material processing and conveying system has been installed. It consists of a fluidized bed dryer, a storage bin, a sieving system, an elevating and screw conveyor system which

can be used to reload the flume or to supply the hopper. The system can also be used to supply material for other parts of the laboratory.

4. **Environmental Rooms**

These rooms were virtually completed by the end of 1973 and were in the testing stage in December. There are in total three rooms contained within a structure 18.3 m long by 6.1 m wide.

In Room B, designed for cold-weather testing instruments, the specifications and dimensions are:

Length	6.1 m
Width	3.65 m
Height	2.43 m
Minimum temperature	−30°C
Temperature control limits	± 1°C
Temperature uniformity	± 2°C

Room A and Antechamber: The remainder of the t

View of tilting flume, 1-metre wide, in the Hydraulics Laboratory. Maximum slope is 5%.

View of inclined plane with meandering channel. Behind, the 2-metre wide tilting flume for sediment studies can be seen. Beyond that the tunnel for the wind/wave flume under construction is shown.

space is given over to a large rectangular room with a smaller attached antechamber. The whole space, however, is specified to meet the following:

Minimum temperature	-30°C
Temperature control limits	$\pm$ 0.5°C
Temperature uniformity	$\pm$ 1°C or better

Separate systems and controls are used for these two main areas. Air is circulated through the roof panels to avoid any local air jets. The cooling units always operate at full capacity, no shutdown is needed for defrosting and temperature control is obtained by adding heat to the cooled air supply. These rooms provide a unique testing facility for ice and cold weather research.

Wind/Wave Flume

Work began this year to install the wind tunnel, its fan, the circulating pumps, control room, data acquisition and control equipment, the programmable wave machine and the wave absorbing beaches. When complete, this flume will provide a unique experimental facility for work in coastal engineering, lake and reservoir problems, wave run-up, overtopping, forces on structures and optimum coastal protection designs. Basic studies on air water interactions will also be possible. When completed, the flume will have the following basic specifications. All should be ready by no later than July 1974.

The facility consists of a contrete flume with hammerhead beach. It will be enclosed by a wind tunnel and is intended for study of wind generated waves and their interaction with structures.

Description:	Width	4.5 m
	Height of side walls	1.48 m
	Gross lengths	83.25 m
	Hammerhead beach	13.70 x 19.2 m
	Maximum water depth	1.25 m
	Minimum water depth	0.60 m

Equipment for 1973/74:

Wave generator – a hydraulically driven piston which can generate uniform as well as random waves
– frequency range – .125 cps – 3.33 cps
– maximum stroke 0.7 m
– a solitary wave can also be generated

Water recirculating system – water can be recirculated in the flume in either direction of a reversible, axial pump
– maximum flow rate 0.85 m^3/s
– maximum current velocity in the flume
15 cm/sec (for depth 1.25 m)
30 cm/sec (for depth 0.6 m)

Wind tunnel – a closed circuit of timber structure width 4.5 m; height of the ceiling above the top of flume side walls – 1.55 m.
– air velocity range 15.2 cm/s – 15.2 m/s
– accuracy of velocity control – plus or minus 1%
– the velocity profile can be controlled at entry.

HYDROMETRY UNIT

In January, the towing carriage was turned over to the Division for operations and after some early minor adjustments, the carriage has been running steadily and reliably throughout the year. The first meters were calibrated on February 27, 1973 and since then a total of 400 meters have been calibrated ranging from simple impulse meters such as OTT or Gurley Price to more elaborate types such as Geodyne. The Unit designed and supervised the construction of a Great Lakes Water Levels display. This demonstration model shows the Great Lakes in their hydraulic aspect and correctly indicates relative surface areas, relative mean depth, stage discharge curves and flood routing through the system.

Hydraulic model studies of culverts to establish modifications to permit the passage of migrating fish were undertaken on behalf of the Hydraulic Design Assessment Committee of the Environmental Working Group on the Mackenzie Highway. The tests were done in the 1m flume and the results are expected to provide the data essential for engineering modifications to culverts where fish migration must take place under a wide range of conditions, it was essential to seek a virtually universally applicable solution.

TECHNICAL SERVICES UNIT

The Technical Services Unit is responsible for providing assistance to scientists and engineers of the Hydraulics Division with their projects. Duties range from design and construction of experiments to field and laboratory tests and measurements and subsequent analysis. A "light" machine shop provides repairs to current meters and to construct specialized small parts for experiments. The Unit also contracts work to local industry and co-ordinates work with the central machine shop at the Centre. At the latter portion of the year, carpentry requirements were such that it was decided to hire a full time carpenter so that there would be less danger to inexperienced technicians and to ensure quality of work in wooden structures.

Electronic maintenance of equipment is also provided and liaison and co-ordination with other specialized electronic groups at CCIW maintained.

During the year, the workload exceeded the available permanent manpower and the Unit added temporary technicians by contractual arrangements through technical manpower service companies.

RESEARCH ACTIVITIES

A systematic experimental study of the rate of reaeration of flowing water and the hydraulic parameters which control the reaeration was completed and a report prepared. For this study a special flume was designed and constructed.

The flume was designed by the Scientific Support Division. Its basic design specifications are as follows:

Length	31 m
Width	61 cm
Recirculating maximum flow	.028 m^3/s

The reaeration tests established that the reaeration coefficient k_2 for an open-channel flow, defined as the oxygen absorption rate divided by the oxygen deficit, could not be described by a single equation because the dimensionless reaeration parameter was a function of two variables, namely the Reynolds number and U_*/U where U_* is the shear velocity and U is the mean flow velocity. Figure 1 illustrates the experimental results. The results of this study are of major significance and value to scientists and engineers concerned with the formulation and value of models of oxygen depletion in river systems and on ways to artificially augment natural aeration of oxygen depleted waters.

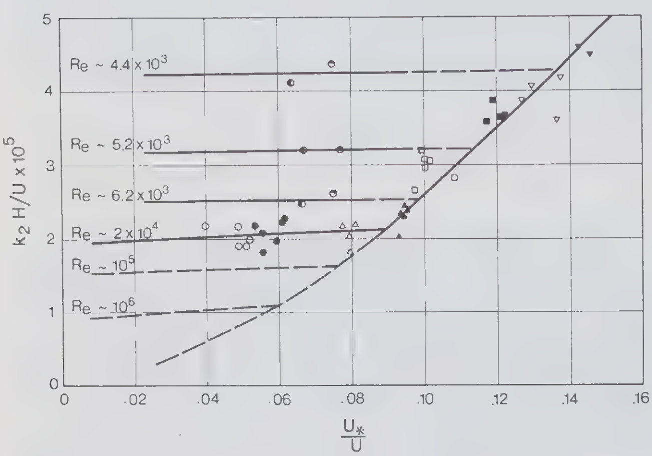


Figure 1. Dependence of the reaeration variable on Reynold's number and dimensionless shear velocity.

Previous work on the diffusion of heat or B.O.D. in straight channels was continued by using a specially designed inclined table in which channels of varying sinuosity could be constructed. In addition to a numerical solution for the convective diffusion equation, the experiments are being undertaken on a dimensional analysis basis to ensure that the parameters studied are independent.

Numerical methods to predict the nearshore wave surface energy from the offshore energy were developed further. Field measurements were made off Burlington Beach in an area where refraction effects are expected to be low. Waves are measured and telemetered to the laboratory by accelerometer wave recorders placed in deep and shallow water. Comparisons are being made of the observed an predicted energy loss from deep to shallow water. Th work is expected to continue in 1975 at another locatio In addition, experiments will be conducted in the lab ratory.

During the spring, the occurrence of severe ice pili on the shores of Lake Simcoe was investigated and t likely cause and mechanism postulated. Calculations bas on the thesis seemed to bear out the observations and research paper was prepared and published. In the autum plans were again underway to measure the friction drag water on the ice in the Grand River. A smaller number stations was set up in this instance. In the spring the proje had to be abandoned owing to very mild weather.

During the year, a very small wind tunnel was design and constructed in the laboratory to study the feasibility measuring evaporation from flowing water by means natural radioactive tracers.

Near the end of the year, a study of oil spill boomi techniques and a review of the criteria for placing oil sp booms was started. A research scientist was hired under term contract to aid the Division with this work.

Laboratory and field studies were initiated to inv tigate the feasibility of estimating the transport of coar sediments in rivers from the acoustic noise generated rolling or impacting particles. Attempts to record gra noise during spring runoff in the Chilliwack River in Briti Columbia were, however, unsuccessful because bel normal runoff did not produce any movement of sedimer at the observation site. The study is to continue in 1974.

A report outlining drainage and sediment cont problems was prepared to assist in the formulation environmental guidelines for land areas undergoing urba zation or development.

A second edition of a manual of S.I. Units for fl mechanics was prepared and the opportunity taken correct errors and improve some portions. This manual proved to be in high demand from many sectors.

Work was also undertaken in support of the Cana U.S. Water Quality Agreement and the Canada/Onta Agreement with respect to reducing pollution from co bined sewer systems. The Hydraulics Division supervise contract with a consulting engineer to evaluate and devel a working numerical programme which would pred within acceptable limits the peak flow and the fl hydrograph in a sewer if the rainfall were known a certain characteristics of the terrain drained, described measured. The studies were undertaken with close operation between the consultants and the Division an was found that really usable knowledge was rather less th claimed in the literature. It was some time before three four models could be evaluated. Field data were obtair to compare measurements with the models. Field studies catchment areas were also done directly by the Hydrau Division in support of the Canada/Ontario Agreement. was found that measurements of fluid flow in sewers w subject to substantial errors making it virtually impossi to routinely obtain accurate information on pollut discharges. The Division studied various commer

ımpling and flow measurement devices with the objective f recommending the most suitable and accurate method ommensurate with acceptable cost. This work should rove to be of great potential benefit to municipal and onsulting engineers.

In support of the Canada/U.S. Agreement, model udies were undertaken of the dispersion of sediment when is released from a hopper in deep water, as is often done s a means of disposing of dredged material. The behaviour f such material is quite unknown and theories are being eveloped based on the experimental observations. It has een established that the sediment sludge does not behave in the same manner as a dense sludge of liquid released into a body of less dense liquid. In further support of dredging studies for the Canada/U.S. Agreement, specifications were drawn up and a contract was awarded to consultants to obtain and consolidate existing knowledge and data on the onset of sediment movement. A theory, based on probability, to define the onset of sediment motion has also been prepared and will be followed up with experimental work in the future. This study is to assist in determining whether means can be found to take advantage of sediment transport processes to reduce the frequency of dredging of contaminated sediment.

LAKES RESEARCH DIVISION

The objective of Lakes Research Division, in the broad rms of reference of Environment Canada and the Environmental Management Service, is to provide government with cientific knowledge needed for managing the freshwater esources stored in Canada's lakes. Accordingly, Lakes esearch Division has two essential functions: 1) to erform basic research to increase scientific knowledge in e field of limnology, i.e., the science of lakes and lake ehaviour or processes; and 2) to deliver scientific tools eeded by management to solve present and future environmental problems related to lakes.

During 1973 a new organization of Lakes Research ivision became operative, to better cope with revised bjectives of the Division and to separate more clearly the esponsibilities for resource survey and description (Lakes esources Subdivision) from process oriented research Geophysical Limnology Subdivision and Chemical Limnology Subdivision).

During the year, the Palaeoenvironmental Research Group of the Water Resources Branch from Calgary joined CCIW to work closely with Lakes Research Divison and is now emphasizing its activities in the Great Lakes region.

During 1973 the Division remained strongly involved in the International Field Year for the Great Lakes (IFYGL) but the major portion of the activities is now centered around tasks relating to the Canada/U.S. Agreement on Great Lakes Water Quality.

LAKES RESOURCES SUBDIVISION

Lakes Resources Subdivision undertakes and coordinates multi-disciplinary lake studies in connection with: IJC references, federal-provincial agreements under the Canada Water Act, and the Great Lakes Water Quality

Figure 2. Lake Superior network of measurement stations.

Agreement. Development of descriptive lake-assessment techniques, and limnological data processing form a major part of the work of the Descriptive Limnology Section at CCIW, Burlington.

In addition, research direction is provided to the regional Lakes Research Division component at the Freshwater Institute in Winnipeg, and to the newly-formed Pacific Region Detachment in Vancouver.

Great Lakes Surveys

The primary effort of the Descriptive Limnology Section during 1973 was devoted to continuing research surveys of open lake processes. The major survey of the year was carried out on Lake Superior as a portion of the IJC Upper Lakes Reference. Less intensive and less frequent surveys were carried out on Lakes Huron and Ontario while a combined effort, in cooperation with the United States Environmental Protection Agency, provided an intensive surveillance of Lake Erie.

All open-lake survey efforts consisted of comprehensive sampling programmes including physical, chemical, geological, biological, and microbiological parameters. As such, they are cooperative programmes planned by scientific staff of Lakes Research Division and Great Lakes Biolimnology Laboratories and carried out with assistance from Scientific Operations Division and the Great Lakes Water Quality Laboratory of the Water Quality Branch.

Lake Superior Survey: The Lake Superior survey was the first large-scale, comprehensive, lake-wide survey ever carried out on this lake.

The Lake Superior field programmes comprised a series of six monitor cruises; continuous measurements of meteorological parameters in mid-lake; and water temperature and current time series recording at thirteen moorings (Figure 2). The highly successful programmes yielded a large body of information on circulation, temperature structure, nutrients, major ions and trace metals, bottom sediments, productivity, phytoplankton, zooplankton and bacteriology.

Continuous current flow and water temperature information was obtained from late May to early October. The onset of general counter-clockwise flow in the lake was observed at the beginning of June. For the rest of the measurement period, flow direction was remarkably constant but strong fluctuations in current speed occurred, sometimes with a well-defined period of about five days.

The six monitor cruises at intervals of five weeks, starting in mid-May and ending in late November, were sufficient to describe, for example, changes in the nutrient content of surface waters between the times of spring overturn and the start of winter overturn (Figure 3a). For each cruise, strong correlations occurred among circulation, temperature structure, and distribution of measured chemical parameters. Internal adjustment of the distribution of density to the counterclockwise flow occurred, requiring accumulation of warm surface water on the periphery and upwelling in the middle, with the result that in mid-lake surface temperature was lowest, the hypolimnion shallowest, and nutrient concentrations highest (Figure 3b).

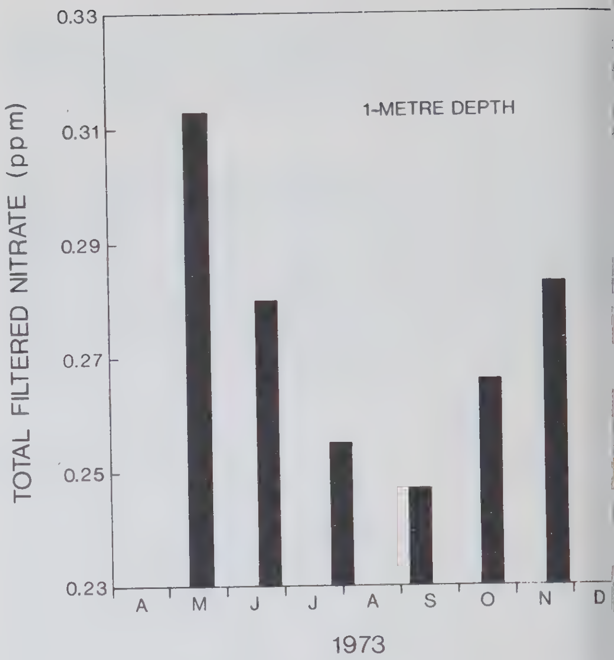


Figure 3a. Lake Superior average nitrate concentration at 1-m depth.

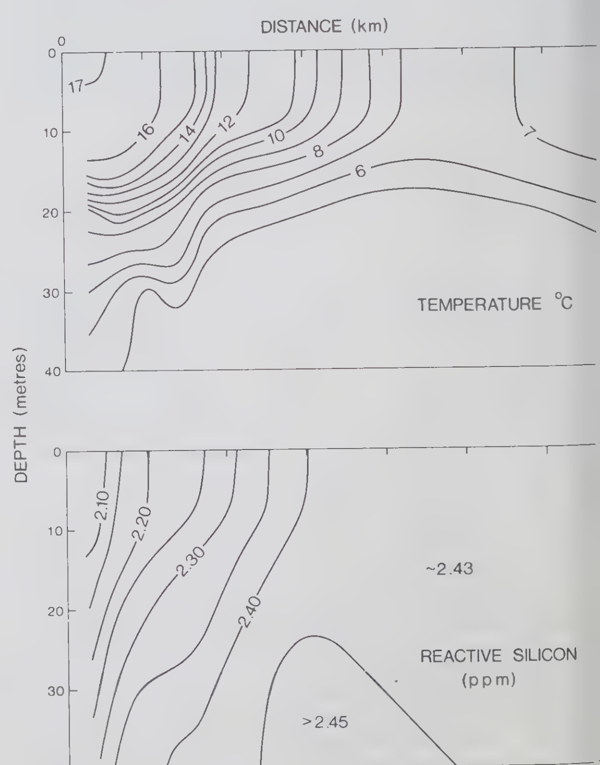


Figure 3b. Vertical cross-section of temperature and reactive s concentration for Lake Superior, August 1973.

Lake Erie Surveillance: The experimental measure-
nts carried out on Lake Erie during 1973 were designed test the ability to determine lake status from a less nprehensive but more intensive series of measurements. ree cruises were carried out by CCIW on which intensive ırshore measurements of the primary nutrients were nducted. These cruises were coordinated with weekly or weekly cruises sponsored by the U.S. Environmental otection Agency on which a limited number of para- ters were measured. Emphasis was placed on determining oolimnetic oxygen depletion.

While final analysis of these data is not complete, oxic conditions were again observed in the hypolimnion the Central Basin. Examination of the phosphorus levels served during 1973 and prior years has been completed. examination of data for 1970 shown in Figure 4 icates that the phosphorus content of Lake Erie in any e year is highly variable. This makes any trend assessment ficult to establish. However, there seems to be a slight crease in the phosphorus concentrations in the Western sin, while the Central Basin apparently shows an increase. ere is no discernible change in the Eastern Basin levels. ch observations must continue in future years if trend terns and steady state concentrations are to be estab- ned.

A report on the status of chemical parameters in Lake e has been prepared for the IJC.

Lakes Huron and Ontario: Few surveys were con- cted on Lakes Huron and Ontario during 1973. Three ises were conducted on Lake Ontario as a follow-up to International Field Year and two very abbreviated ises were carried out on Lake Huron on which only the ter Quality network stations were sampled.

Further analysis of the extensive Lake Huron measure- nts of 1971 and 1972 was carried out and reported to IJC.

Preliminary analysis of the Lake Ontario IFYGL asurements has been carried out on available data. wever, a large portion of the observations remain unverified and will not be available for analysis until some time in 1974. Preliminary analysis of Lake Ontario data has been incorporated in the 1973 IJC status report.

Studies of primary production were made on several cruises on Lake Ontario during IFYGL. Daily production was computed based on a series of limited period *in situ* C^{14} experiments, covering all daylight hours. As an example, the primary production at an offshore station in Lake Ontario is shown in Figure 5.

Trends in Great Lakes Water Quality

Dissolved inorganic nutrients and related water quality in the four international Great Lakes have been summarized and compared in a paper, A Summary and Comparison of Nutrients and Related Water Quality in Lakes Erie, Ontario, Huron and Superior by Dobson, Gilbertson and Sly (in press). Data analysis was devoted to obtaining mean values in surface waters in a large offshore region in each basin. It is recognized, however, that detailed sections and plans of the distributions would also be useful at a more detailed level of interpretation. The summary includes those parameters that will be needed in an assessment of long-term trends.

A preliminary scheme for characterizing surface waters has been derived from analysing observations of Lakes Erie and Ontario. From the relationships observed, it is suggested that the trophic state of the lake can be characterized "mesotrophic" if the following variables fall within the given ranges:

Secchi depth (transparency) 6.0 to 3.0 m
Total chlorophyll *a* 4.4 to 8.8 μg/l
Total phosphorus 8.7 to 17.4 μg/l

This scheme is tentative and requires further verification but does appear to be able to define significantly different trophic conditions observed in the Great Lakes. For example, a graph of secchi depth cycles and interpretive ranges is given in Figure 6. Secchi depth reciprocals are used as a linear scale in the left and secchi depth as a corresponding non-linear scale on the right.

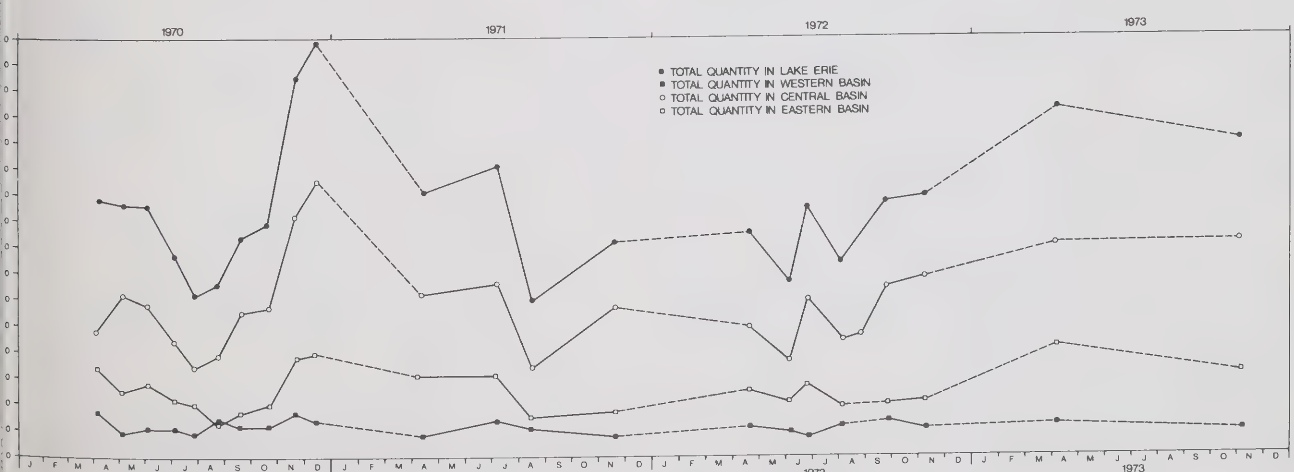


Figure 4. Quantities of total phosphorus in Lake Erie, 1970-73.

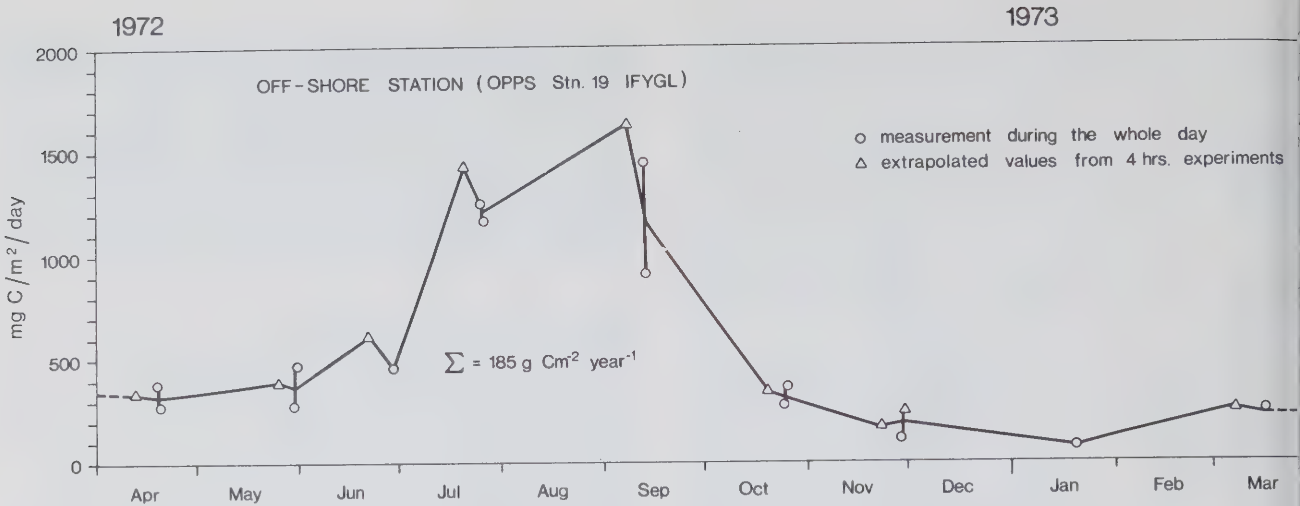


Figure 5. Daily carbon uptake rates in Lake Ontario (offshore station).

Waste Heat Studies

Studies related to the disposal of waste heat in the Great Lakes area have been undertaken by several groups within the Centre: Lakes Research Division, Social Science Research and the Great Lakes Biolimnology Laboratory. This section will deal only with the projects carried out within Lakes Research Division.

The 1973 programme has been carried out through two industrial contracts and one in-house project. These three projects form a portion of the overall effort aimed at defining the environmental effects of waste heat and the costs of alternate methods of heat disposal.

(a) Study of the Benefits and Costs of Offshore Diffusers as Waste Heat Discharges: This project was contracted to H. G. Acres Consulting Services Ltd., Niagara Falls.

A physical model of an offshore diffuser outfall has been developed which simulates the plume dimensions in terms of the thermal contrast to the environment. This model has been applied to all existing power generation sites on the Great Lakes and to typical sites for projected development to determine the benefits gained through reduction of lake area affected by the heated discharge. Estimates were made for the cost increases over direct shore outfalls.

(b) Study of the Effects of Waste Heat on the Water Budget of the Great Lakes: This project was contracted to H. G. Acres Consulting Services Ltd., Niagara Falls.

Waste heat rejected to the waters of the Great Lakes causes a change in the lake energy budget through increases in heat input. This causes the lake temperature to increase and the heat to be dissipated by increased evaporation, radiation and sensible heat. Increased evaporation influences the water budget of the lake.

This study (which is not yet complete) is to assess the magnitude of the water loss to the Great Lakes System due to the addition of heat. The water loss which would occur if wet cooling towers were employed will also be estimated to compare relative influences on the water budget.

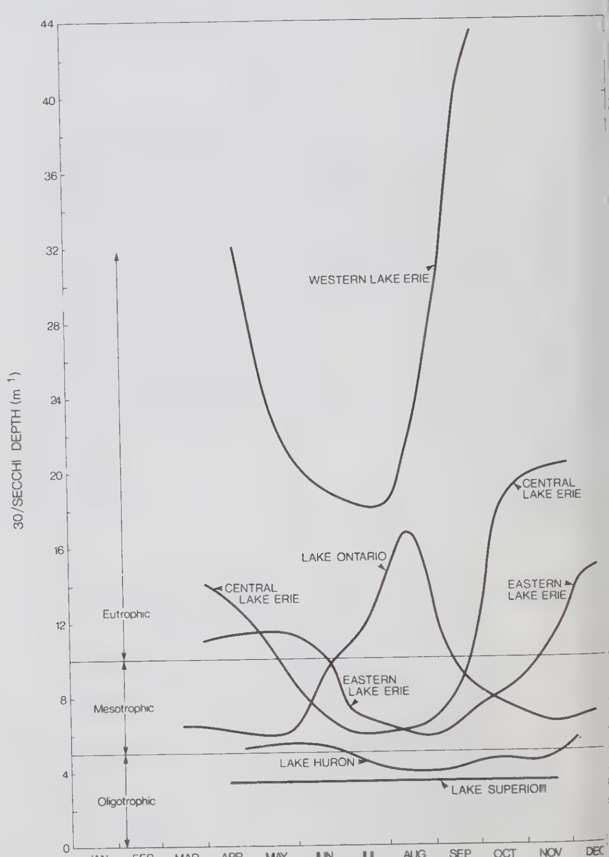


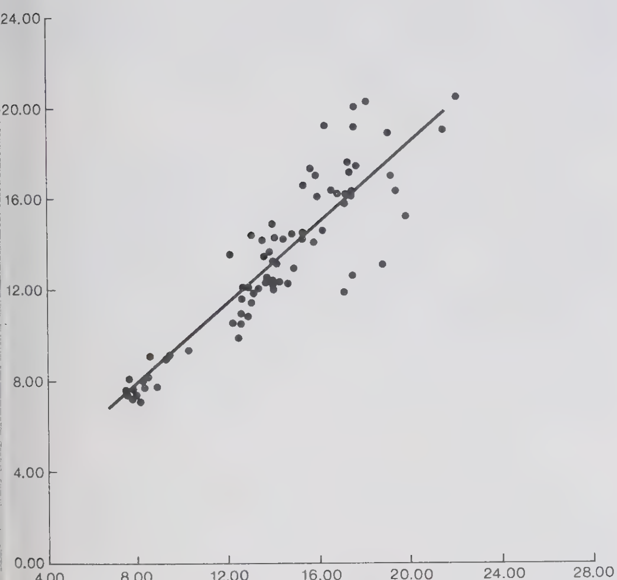
Figure 6. Seasonal cycles of turbidity in surface waters of the Lakes as indicated by secchi depth observations. smoothed curves were drawn from data obtaine synoptic cruises by CCIW in 1969-1971.

Lake Ontario Nearshore Temperature Analysis: asurements of the nearshore water temperature of Lake tario made over the past three years have been compiled d analysed statistically to describe the natural thermal imes. Means, standard deviation, and coefficient of iation were determined for the data available each nth at Kingston, Point Petre, Cobourg, Oshawa, ronto, Burlington and Port Weller. Similar daily computions were made for Oshawa for January and February to termine winter variations. A mean daily standard devian for this month was found to be 0.17°C.

Correlations between sites were computed to determe the necessity of the number of stations to describe the nearshore regime. Extremes of the correlations are shown in Figures 7a and 7b which relate Cobourg and Oshawa and Oshawa and Burlington respectively.

Fate of Organic Compounds from Point Source Effluents

In 1973 a feasibility study was carried out to determine the extent and effect of the mixing zone of the effluent from a Kraft Pulp Mill at Marathon, Ontario, on Lake Superior. In this study, Lakes Research Division attempted to identify individual organic compounds (especially those known to be toxic or to cause fish tainting) and to determine their zone of influence in the receiving water.



ure 7a. Correlation of 10-metre depth water temperature off Cobourg and Oshawa.

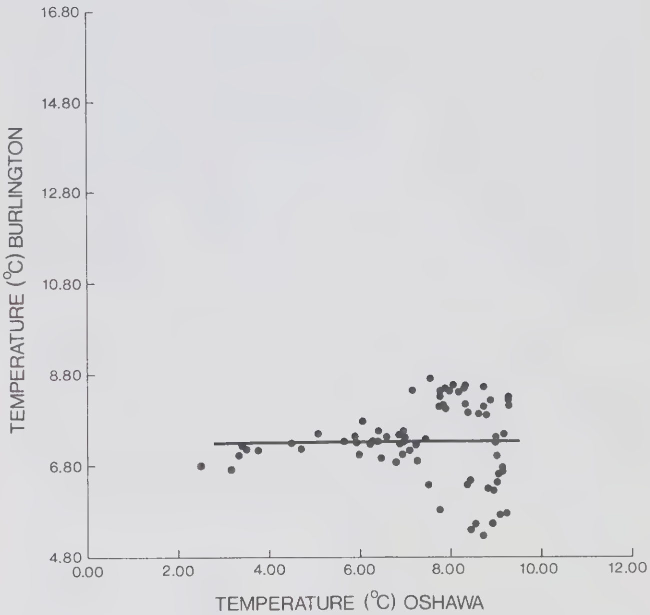


Figure 7b. Correlation of 10-metre depth water temperature off Oshawa and Burlington.

Figure 7c. Normal weighted running mean, Kingston bottom sensor, 1972.

A practical method of extracting the organics was devised using a macroreticular resin (XAD2). Samples were collected in a cooperative field programme with Great Lakes Biolimnology Laboratory. The amounts of organics recovered were found to be closely related to dissolved organic carbon measurements and to sodium ion concentration, indicating overall dissipation by simple mixing with the receiving water. Individual compounds are currently being separated and identified by GC/MS and it is hoped to determine whether significant differences in individual dissipation rates occur due to processes such as absorption, degradation or uptake by organisms.

Determination of Energy Fluxes for Lake Ontario during IFYGL

Meteorological data measured from 19 April to 5 December, 1972, during the International Field Year, have been evaluated to determine the magnitude and time variation of the fluxes of heat and moisture (evaporation or condensation) from Lake Ontario. The analysis has employed conventional exchange coefficients applied to hourly averaged meteorological observations obtained from only the Canadian portion of the IFYGL network. Lake-wide estimates of the fluxes have been obtained by computation of a best fit second order surface to the existing data.

The resulting estimates of daily fluxes of heat and moisture were summed over weekly periods for comparison with other terms of the lake energy budget. The resulting weekly values are shown in Figure 8. While these values must be considered preliminary due to lack of data from the United States network, they give a useful estimate of the total fluxes and of the time variations throughout the year.

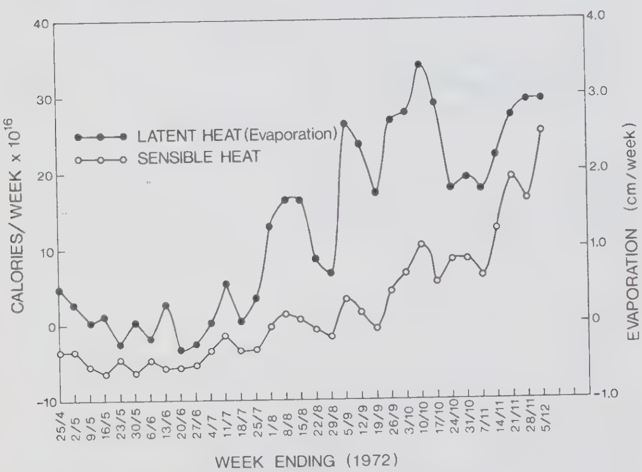


Figure 8. Preliminary estimates of heat fluxes for Lake Ontario during the International Field Year 1972.

Current Measurements in the Great Lakes

Measurements of current flow and temperature in 1973 were made in three lakes: in Lake Superior, as part of the IJC Upper Lakes Reference; off Douglas Point in Lake Huron, in support of a waste heat study; and off Bronte in Lake Ontario, as a major part of an investigation of the characteristics of the nearshore flow regime. The last two studies are described under activities of the Physical Limnology Section. In Lake Superior, time series records were obtained at thirteen moorings (31 current meters during the May to October period (Figure 2). Included among these were measurements off Eagle Harbor, Michigan, which were part of a study of the Keweenaw Current, carried out in cooperation with the University of Wisconsin, (Madison).

Current meter data processed and edited during the year included 1972/73 winter observations from Lake Ontario for the IFYGL program; most of the data from the projects mentioned above; all of the past information obtained by CCIW in Lake Huron; and some of the existing files for Lake Erie. Limited data processing was also provided for Marine Sciences Directorate (CCIW) and the Ontario Ministry of the Environment.

Meteorological Support Program

Meteorological measurements made in support of the scientific programs of the Centre continued in Lakes Research Division during 1973 (Figures 9a and 9b). The measurements were made (a) as a continuation of the IFYGL Energy Balance study of Lake Ontario, (b) in support of the comprehensive Lake Superior Survey for the Upper Lakes Reference, (c) in support of the Bay of Quinte studies, (d) in support of the Kenora ELA studies and (e) in support of the Wolfe Island ice movement studies (Glaciology).

Data were generally obtained through use of the automatic meteorological system mounted either on buoys or towers. In some cases only solar radiation records were obtained. Data have been processed and validated and used to compute the energy fluxes for Lake Ontario or in support of special project requests.

CCIW Winnipeg Detachment

A small group is working in conjunction with the Freshwater Institute in Winnipeg. Dr. T. Jackson is Acting Head of the group whose work is presented in the following sections.

An additional staff member is being sought as programmes develop in response to IWD Western Region problems. To a substantial degree, the future interest lies with lacustrine aspects of reservoirs.

Dynamics of Fluctuating Surface Currents

The dynamics of fluctuating surface currents responsible for the formation of windrows are being studied on Lake of the Woods. Although this phenomenon is universal to all fresh and marine waters, Lake of the Woods is dominated by windrows of surface foam whenever the wind is sufficiently strong to produce breaking waves. The surface windrows result from the foaming tendency of the eutrophic waters of the lake and its large blooms of blue-green algae "aphanizomina flos aqua." Pulp mill effluents which foam profusely are also characterized by intense surface windrows. Heavy rainfall has been observ

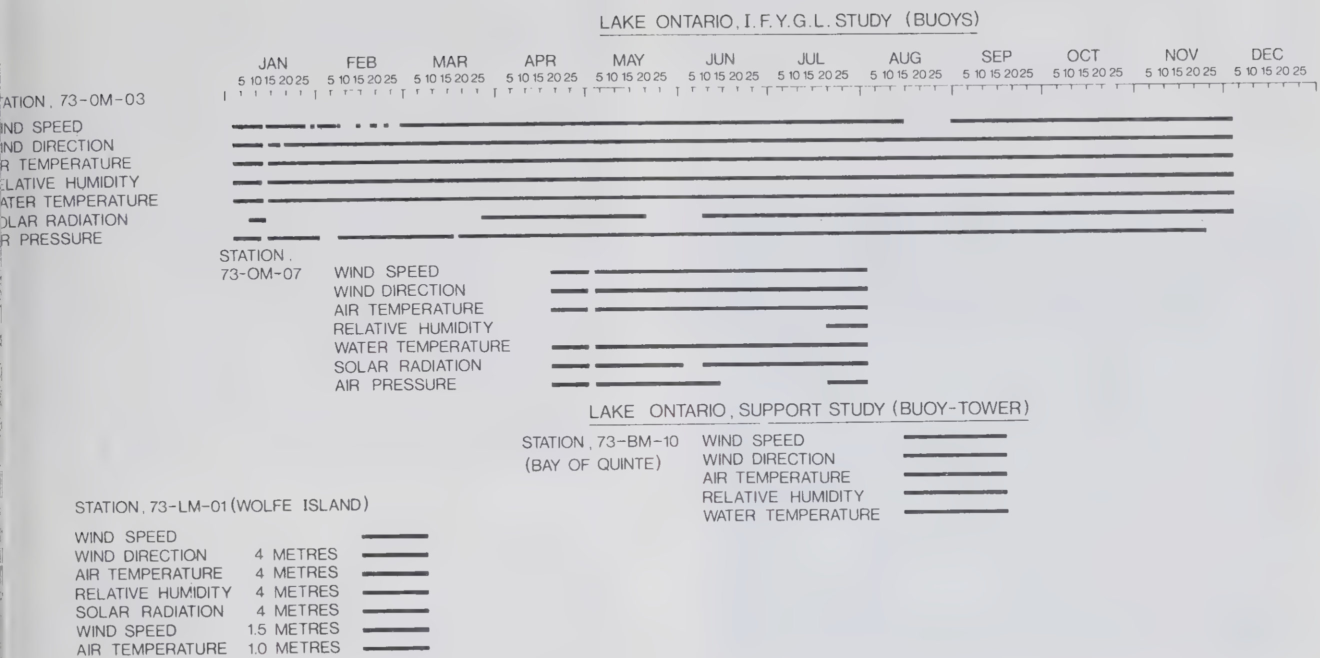


Figure 9a. Record of meteorological measurement data.

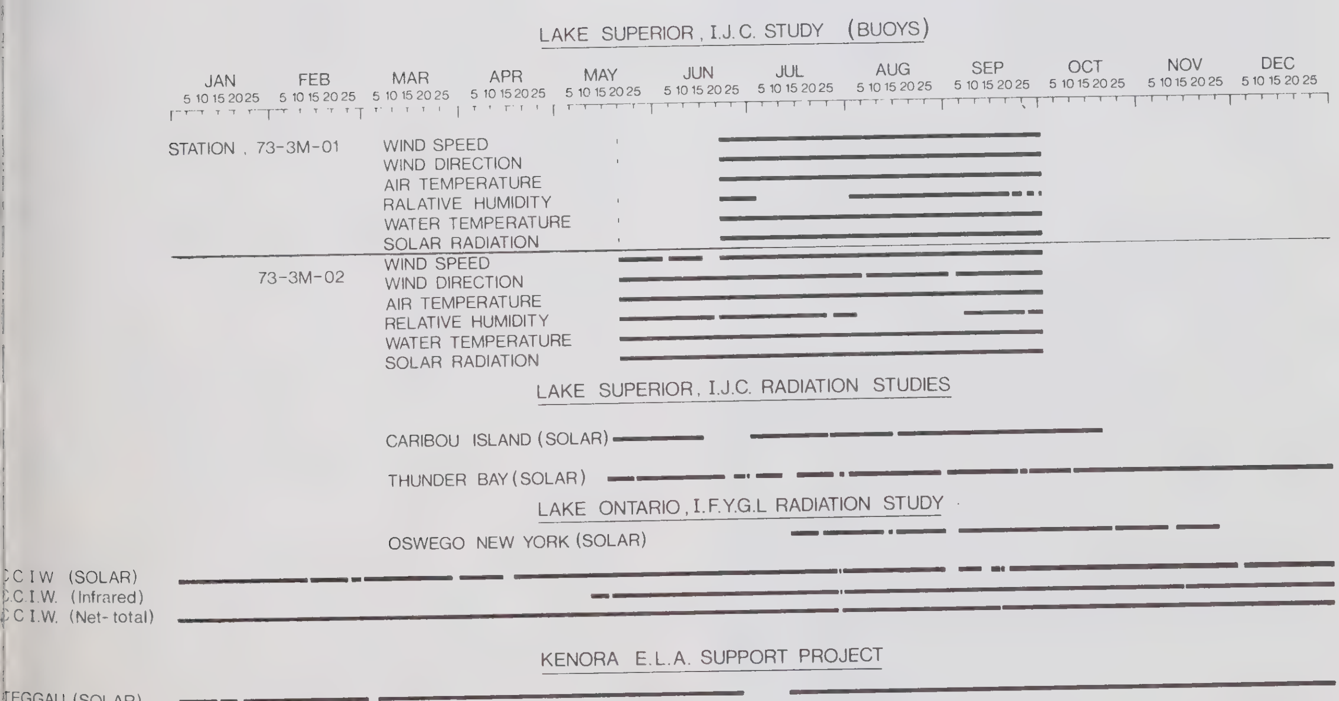


Figure 9b. Record of meteorological measurement data.

to completely attenuate surface windrows by breaking up the foam while leaving the sub-surface, quasi-organized current structures unaffected. These same fluctuating currents also produce a striated effect in subsurface effluents which may be observed in the absence of surface windrows. This is the more usual situation in the Great Lakes which have little tendency to foam.

Windrows of surface foam on Lake of the Woods.

Length and time scales of windrows were measured by time lapse vertical aerial photography as a function of wind speed, fetch, surface waves and water depth. Simultaneous measurements of velocity shear and the vertical correlation of current and temperature fluctuations and their phase relation to visible windrows were curtailed when the instrument platform collapsed during an intense line squall early in the field season.

Biogeochemistry of Lake Sediments

Research in 1973 was concerned with the role of humic matter in the biogeochemistry of phosphate, transformation of labelled phosphate and the biogeochemistry of the sediment-water interface.

Samples were collected from the Experimental Lakes Area (ELA) of northwestern Ontario, from a lake in southwestern Manitoba and for Clay Lake, Ontario. Some cores have been prepared for electron microprobe analysis and the mud and water samples analysed for Fe, Al, Ca, P and C. Considerable time has been spent on testing various procedures to extract and isolate humic complexes of metal and phosphate.

Results so far strongly suggest that the organic phosphorus compounds of approximate molecular weight 250 may be nucleosides or a similar type of compound. Lake sediments show some regularities in the Sephadex fractions in their chemical composition and properties. Information is developing on the binding of phosphate and added ^{32}P in humic matter, and on the partitioning of added phosphate between the water and mud. Information is also being developed on the relation between phosphorus, iron and aluminum in the fulvic and humic acid from lake mud (ELA).

Palaeoenvironmental Interpretation of Cultural Eutrophi-cation

An investigation of the change in succession of foss communities is being carried out on lake cores from th Bay of Quinte, Lake Ontario. This may reflect changes i the trophic status of the body of water.

Results clearly indicate that such changes are assoc ated with cultural development. Pursuing the questio further, the chironimid necrocoenosis is being investigate to establish whether it follows the natural orderly sequenc of community succession on an accelerated time scale i culturally reduced eutrophication or whether some stag are obliterated. Questions are also being asked to determir whether the effect of pollutants is reversible and wheth they affect chironimids directly or indirectly throug depletion of oxygen levels.

Pacific Region Detachment

During 1973 CCIW established a detachment i Vancouver to carry out CCIW operations in the Pacifi Region of the Inland Waters Directorate. Much time durin the first months of operation was spent in overseeing th acquisition and installation of two laboratory trailers at th Pacific Environment Institute, 4160 Marine Drive, Wes Vancouver. In spite of a four month delay in delivery c these trailers, field work on four British Columbia lakes wa undertaken by Detachment staff.

Pacific Region Limnological Survey

The objective of the Pacific Region Limnologica Survey is to establish a series of data reports on th physical, chemical and geological limnology of the majc lakes of the Pacific Region (Figure 10). It is anticipate that this continuing study will eventually cover most of th significant lakes of the Pacific Region. A detailed literatur search is performed to appraise limnological knowledge c each lake before the lake is surveyed in he field. The fiel work is designed to provide a detailed picture of geologica processes operating within the lake, and to allow a genera classification of the lake by its descriptive limnology.

Pitt Lake, draining into the Fraser River close t Vancouver, was studied in 1973 because of its proximity t the new laboratory. Pitt Lake is tidally influenced throug its connection with the lower Fraser River, and exhibits large delta-form structure at the south end of the lak where the Pitt River drains to the Fraser. It has bee theorized that this "delta" has been deposited by tid currents entering the lake.

Great Central Lake on Vancouver Island has been th object of a five year fertilization experiment operated b the Pacific Biological Station, Nanaimo. Because th fertilization project has effectively doubled the phospha loading to Great Central Lake over the natural level in eac of the last five years, Dr. J.D.H. Williams of the CCIW investigating phosphate diagenesis in the surficial sedimen of this lake. To assist Dr. Williams in his program, th

acific Region CCIW staff elected to study Great Central ake under the Limnological Survey project. Sounding, ırface grab sampling, and coring of this lake were done uring 1973 in conjunction with Dr. Williams' study.

Kamloops Lake, on the Thompson River System of the .C. Interior, is being intensively studied by a number of overnment agencies under a Federal-Provincial agreement gned during 1973. The Pacific Region detachment antici- ates completing an intensive physical, chemical and iological study on Kamloops Lake during the 1974 field eason, and in preparation for this, Kamloops was desig- ated as a Limnological Survey lake during 1973. A detailed cho sounding survey was run in the lake to delineate ediment distributions, made complex by the influence of ne large Thompson River flowing through it. Over 40 mples were taken with a Shipek sampler and about 10 ores were collected. Sample analysis and data reduction on amloops Lake material were given priority during late 973 and early 1974.

abine Lake Studies

The CCIW detachment attempted two projects on abine Lake during 1973 in cooperation with the estab- shed Babine Watershed Change Program. Studies were lanned on the sedimentology, historical geology, and edimentary geochemistry of this large and important lake hich drains via Skeena River to the Pacific Ocean. These udies were hampered during 1973 by logistic difficulties but it is anticipated that the Babine Lake work will be completed during the field season of 1974.

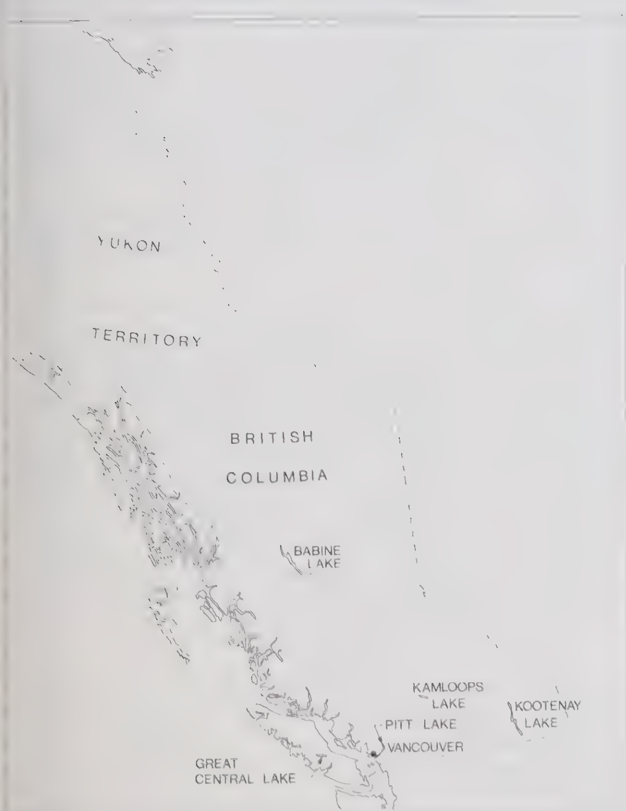


Figure 10. Lakes under study by the Pacific Region Detachment.

Future Studies

During 1974, it is anticipated that the Pacific Region detachment staff will increase to five scientists with accompanying technical, field operational, and clerical support. Projected studies under the Limnological Survey Project include the completion of work on Great Central Lake, Pitt Lake, Babine Lake, and Kamloops Lake (geological studies only). In addition it is planned to initiate a geological programme on Kootenay Lake in southeastern B.C. and to acquire the capability to work on remote sub-Arctic lakes in the Yukon.

The greater part of the Detachment's effort, however, will go to Kamloops Lake for an integrated study involving physics, chemistry, and biology. The study will be undertaken as a national programme with additional support from CCIW in the form of equipment, field personnel and analytical assistance.

As a general summary, more than 50% of all the Division's resources are presently committed to support the Canada/U.S. Agreement. Consequently in the Division, scientific research aimed at more fundamental problems has been reduced. Hopefully, however, continuation of long-term research aimed at a more basic understanding of processes in lakes will be broadened again in the near future.

CHEMICAL LIMNOLOGY SUBDIVISION

This group of specialists provides fundamental understanding of chemical processes in lake waters within the broad field of chemistry. In addition, the subdivision carries out studies on the impact of introductions of natural and man-made substances in lake systems, with special emphasis on their limnological behavior, complex interactions and relationship to lake water quality.

Water Chemistry Section

The projects carried out in this section include measurements of the partial pressure of carbon dioxide in air over Lake Ontario, laboratory investigations of the methylation of lead, the impact of chelated and excess copper on algae, the identification of individual trace organic compounds from lake water by GC-MS-computer analysis, the solubilities of various metal carbonate species, and the thermodynamics of model brine solutions.

Complexing Capacity of Lake Waters

A sensitive and accurate method to determine the complexing capacity of lake waters was developed in cooperation with Dr. René Gächter (visiting scientist from the Swiss Federal Institutes of Technology, Federal Institute for Water Resources and Water Pollution Control). This method was applied to a study of the relationship of the complexing capacity of the nutrient medium and its relation to the inhibition of algal photosynthesis by copper.

It was found that the complexing capacity of a water sample does not guarantee that the equivalent amount of copper could be tolerated by the system without adversely affecting phytoplankton production. The results of this study suggest that (free)ionic copper is probably already toxic to planktonic algae at concentrations in the order of 10^{-10} mole/l.

Methylation and Toxicity of Lead

Preliminary experiments indicated that inorganic (lead nitrate) and organic lead (di- and tri-methyl) can be converted by microorganisms to volatile tetramethyl lead only under anaerobic conditions in lake sediment. The conversion from di- and tri-methyl lead to tetramethyl lead is much more rapid than that from lead nitrate in a simulated lake water-sediment culture system. The methylation of lead has not been reported in the literature before. The methyl lead compounds (di- and tri-methyl) were found to be much more toxic to algae and bacteria than the inorganic lead.

In connection with this joint project with Great Lakes Biolimnology Laboratories, a method has been developed to determine the various forms of methyl lead. Studies in progress include factors affecting the methylation process, the pathway of the methylation and the concentration of methyl lead compounds by aquatic biota.

Metal-Fulvate Complexes

Conditional stability constants, K, of some metal fulvate complexes have been determined at 25°C using specific ion electrodes. The log K values are graphically shown in Figure 11. The order of metal affinity towards fulvic acid (a natural ligand) is in general agreement with that towards artificial ligands such as NTA and EDTA: Hg(II) > Cu(II) > Cd(II).

Soluble Organic Compounds in Lake Water

Sampling was undertaken on all four of the international Great Lakes. Ten metre samples from geographically separated stations (main lake) were obtained for each lake, except Erie, during both spring and autumn periods. For Lake Erie, the sampling occurred during spring, mid-summer and late autumn as well as summer sampling at hypolimnion depths and a mid-lake time series. All samples were filtered immediately (0.22 μ) and stored in full sterile glass bottles previously cleaned with chromic acid.

All samples were continuously extracted with chloroform (as 0.1 M NaCl solutions). Samples are being analysed by gas chromatography-mass spectrometry and comparison of the spectral data is being undertaken with data stored in a computerized spectral library.

Chloroform extractable material was found in the following concentrations (average and range given in mg/l):

	Spring	Summer/Autumn
Ontario	.32 (.18-.93)	.30 (.22-.50)
Erie	.28 (.18-.53)	.31 (.21-.56)
Huron	.17 (.11-.21)	.29 (.24-.38)
Superior	.25 (.16-.44)	.26 (.25-.28)

Resin Acids

Resin acids are produced by coniferous trees, and are introduced into waters in pulp and paper manufacturing. They are fairly toxic to aquatic life, so their fate in the environment is of practical importance as well as an interesting problem in biochemistry. A number of strains of bacteria (all grain-negative rods) which are capable of growing in media containing resin acids as the only carbon source have been isolated from water and soil. The action of these organisms on resin acids is being investigated.

The CO_2 Project

From August, 1972, to March, 1973, the non-dispersive infrared CO_2 analyser and air sampling system was installed on the "Martin Karlsen". The CO_2 concentration in the air over Lake Ontario was measured continuously on five cruises and the partial pressure of CO_2 on the lake was calculated. The air concentration was lowest in the fall (~320 ppm) and highest in the winter (~335 ppm). A diurnal cycle, caused by photosynthetic activity, was observed in the summer months, with lowest values in the evening. The partial pressure on the surface layers of the lake was below atmospheric in the summer, causing a CO_2 flux into the lake of 0.1 – 0.5 gC m^{-2} day^{-1}. In the winter, the lake concentrations were above atmospheric and, because of storms, the flux out was 2 – 3 gC m^{-2} day^{-1}.

In the fall of 1973, an improved version of the sampling system, which allowed a direct determination of CO_2 partial pressures in water, was taken to the Bay of Quinte for measurements on the limnocorrals installed by

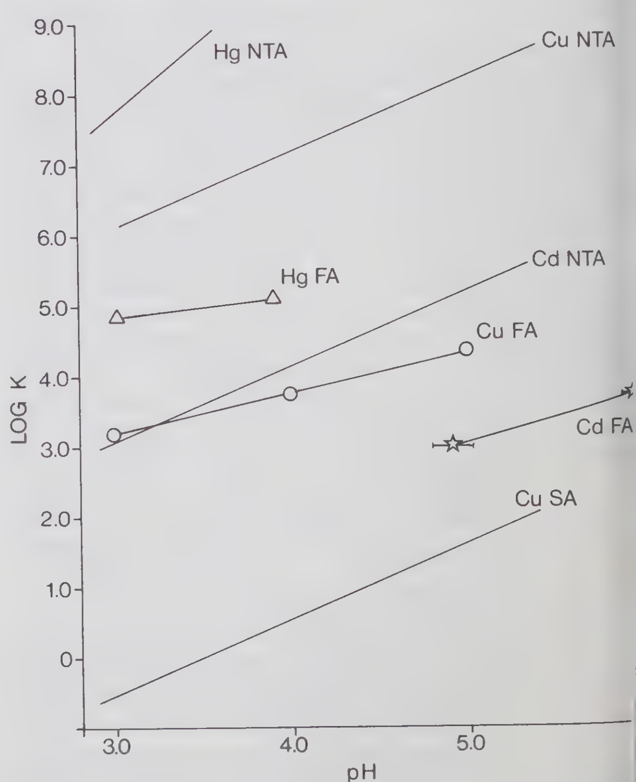


Figure 11. pH dependence of some conditional stability constant

r. D. Lean. Subsequently the equipment was installed on a ›wer about a mile offshore near Burlington to obtain etter CO_2 flux measurements in conjunction with experi-ients by Mr. E. I. Mukammal of AES. The equipment ınctioned improperly and the experiment was terminated hen the tower collapsed in a storm in October. Fortunate-, the analyser had been taken ashore for servicing.

lulticomponent Brines

Thermodynamic measurements are underway on the ystem H_2O – NaCl – Na_2SO_4 – $MgSO_4$ which is ıturated with (halite) NaCl, and future studies will ıclude those on the same system saturated with other ıinerals.

letal Carbonates

A rapid system to measure the solubilities of simple arbonates and hydroxycarbonates under a controlled tmosphere of CO_2 pressure was set up and preliminary ata were obtained for otavite ($CdCO_3$), malachite $Cu_2(OH)_2CO_3$), cerrussite ($PbCO_3$), and poorly charac-erized carbonates of Ni and Zn. The results for malachite nd cerrussite agree with previously published data; the esults for otavite indicate that it is about an order of ıagnitude more stable than previously reported.

recision in Monitor Cruise Data

At the 95% confidence level, there was little significant ifference between bottle and pump sampling methods for ıost of the parameters examined. Precision was largely ependent on the sampling rather than the analytical rocedures and it is recommended that any efforts at nprovement be directed along these lines. Recommen-ations have also been made that the monitor programme ıcorporate regular statistical sampling and that the results e presented along with the data listings.

ieochemistry Section and Geological Survey of Canada etachment

This section has been active in studies of the distri-ution and fate of phosphorus in sediments of the kanagan lakes; the forms and occurrence of iron hydrox-des and phosphates in lake sediments; the occurrence in ediments of chlorophyll and its derivatives; sedimentation ates and geochemical inputs to sediments of the Great akes, including palynological studies by a detachment rom the Geological Survey of Canada; and the chemical orms of nitrogen in sediment organic matter.

Staff of the section also participated in a cooperative tudy of the biochemical transformations of organic matter rom the effluent plume of a pulp mill.

hosphorus in the Okanagan Lakes

The study of the distribution of phosphorus in the urficial sediments of mainstem lakes of the Okanagan 'alley, British Columbia was completed. The forms of hosphorus in the sediments and the factors controlling heir accumulation were in general similar to those found in ther lakes. Apatite derived from erosion of terrigenous materials from the surrounding watersheds or from shallow water deposits within the lakes, accounted for 70% of the sediment phosphorus in Lake Skaha and over half of that in the other lakes. Apatite plays only a minor role in the soluble phosphate budget of the lakes.

Initially, soluble phosphate, which is subsequently removed from the lake waters by sedimentation, accumulates in the sediment as 'sorbed orthophosphate' and organic phosphorus. The content of both of these forms in the surface sediments increases with increasing water depth. Sorbed phosphorus is usually associated with iron in the sediments and organic phosphorus is correlated to the sediment organic matter. The precipitation of calcite in the epilimnion of Kalamalka Lake during the summer months is not accompanied by an appreciable uptake of orthophosphate by the calcite particles. The phosphorus profiles in sediment cores from Wood and Skaha Lakes indicate an abrupt change in conditions of phosphorus sedimentation, following early settlement of the Okanagan Valley, due to the increased erosion in the watersheds surrounding the lakes. The decline of organic phosphorus with depth in the cores is matched by an approximately equal increase in apatite content, indicating mineralization of organic phosphorus. This mechanism of retention of phosphate by diagenetic formation of apatite acts as a very efficient 'sink', retaining almost all phosphorus in the sediments of Wood and Skaha Lakes and occurs in all the Okanagan mainstream lakes.

Forms of Iron Hydroxides in Lake Sediments

Work has commenced on the forms of iron in the Great Lakes sediments. Fe(III) and Fe(II) species were determined in samples from Lakes Erie and Huron. Thermodynamic considerations show that ferrosoferric hydroxide ($Fe_3(OH)_8$) should exist under the moderately reducing conditions found in most of the Great Lakes sediments. Preliminary results indicate that this compound exists in the moderately reduced sediments of the lakes. Studies are continuing.

Diagenetic Formation of Iron Phosphates in Recent Lake Sediments

A method for approximating the thermochemical constants for many basic iron phosphates has been developed and the data so derived used to develop models depicting the phase compatibilities and the general diagenetic behavior of iron phosphates in subaqueous freshwater environments. The models have been combined with measurements on the interstitial waters of Lake Erie to define the chemical requirements for the formation of vivianite and other iron phosphates in the Great Lakes sediments.

In aerobic lake sediments, ferrosoferric (and manganousferric) hydroxyphosphates are the stable minerals (see Fig. 12 for the most probable phases) which may be derived by phosphating ferromanganese oxides or by the oxidation of ferrous phosphates. Strengite and simple ferric phosphates are unlikely to be important diagenetic constituents of freshwater sediments. The stable and most probably phosphate minerals in reducing environments are

vivianite, reddingite and anapaite. The precipitation and dissolution of these iron phosphates (particularly vivianite) in the Great Lakes sediments are considered an important buffer mechanism which regulates both the levels of phosphorus in the interstitial waters and the release of phosphorus to the overlying lake waters.

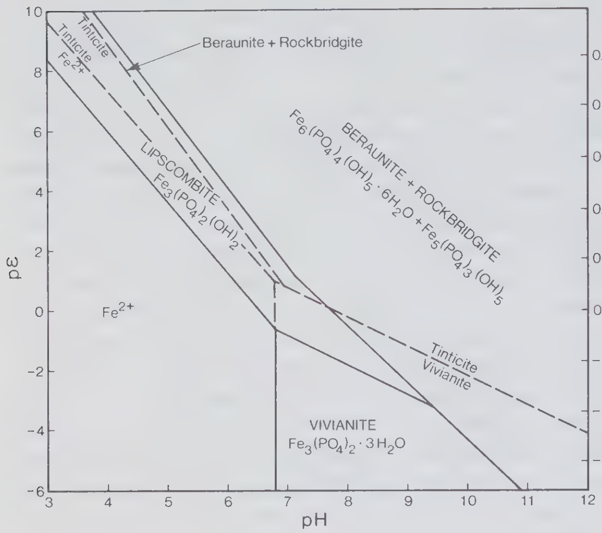


Figure 12. Phase relationships for iron phosphate minerals most likely to be encountered in lake sediments.

Stable Isotope Limnology

Most geochemical processes involve a fractionation of the isotopes of the participating elements. Studies of the sources, behavior and fates of selected isotopes in water can therefore yield important clues on the history of the water itself. Although the use of radioisotopes for dating water in aquifer systems has been well publicized, the technique of using stable natural isotopes to fingerprint pollution sources, determine water residence time or measure rates of water movement, has received limited attention. The acquisition of an isotope ratio mass spectrometer (VG Micromass, Model 602C) in March, 1973 now makes it possible to apply this powerful technique to limnological and environmental problems at CCIW.

Facilities are now available for analyzing water samples and geological materials for natural stable-isotope ratios of sulfur (S^{34}/S^{32}) and carbon (C^{13}/C^{12}). The analytical capability for determining similar isotope ratios for nitrogen (N^{15}/N^{14}) and oxygen (O^{18}/O^{16}) will be added in the coming years.

Several activities were initiated during the year: diagenetic fractionation of sulfur isotopes in the Great Lakes sediments; identification of sources of sulfur in the Great Lakes using isotope-ratio variations as tracers; sulfur isotopic variations in precipitation and lake waters in the Sudbury area, Ontario. In lakes which do not develop bottom anoxia, a reasonable hypothesis is that the sulfate exchange at the mud-water interface may cause a measurable sulfur isotopic effect in the overlying water. Laboratory studies, in fact, show that Lake Ontario sediment possess a significant retention capacity for sulfate and tha the change in δS^{34} caused by the sulfate adsorption range from 0.9 – 6.0% (Fig. 13). Apparently, adsorption desorption processes may play a role in determining th isotopic composition of natural waters as well as recen and ancient sediments.

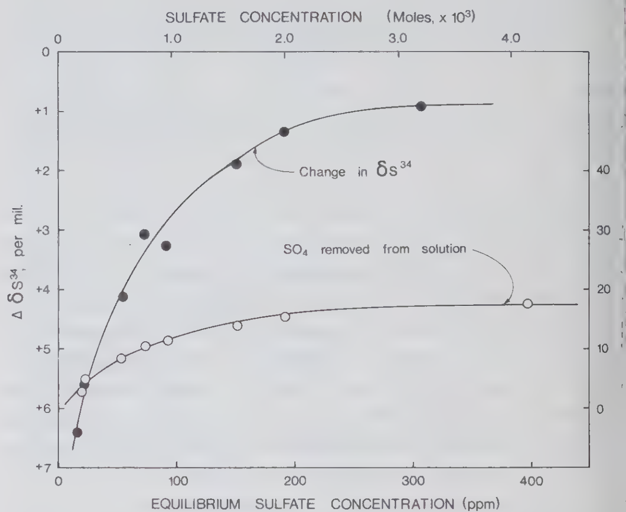


Figure 13. Sulfate adsorption isotherm with corresponding chang in δS^{34} of the sulfate remaining in solution.

Chlorophyll Derivatives in Sediment Cores from Lakes Er and Ontario and South Bay

This project was completed and the results showed th the pheophytin *a* to organic carbon ratio was a reliab relative paleoproductivity change indicator in Great Lak sediments. Unaltered chlorophyll *a* and the most degrad chlorophyll derivative, pheophorbide *a*, did not mainta their ratios to organic carbon. The value of the pheophyt *a* to organic carbon ratio was not comparable between lak so that only relative paleoproductivity changes within lake could be determined.

Point Source Effluent Study

Tracking and sampling the effluent plume of a pu mill in Marathon, Ont. was undertaken in conjunction wi the Great Lakes Biolimnology Laboratory of the Fisheri and Marine Service and the Descriptive Limnology Sectio The samples were obtained for analysis of carbohydrat and proteins to ascertain the biochemical transformation wood sugars in a pulp mill effluent plume entering the op lake.

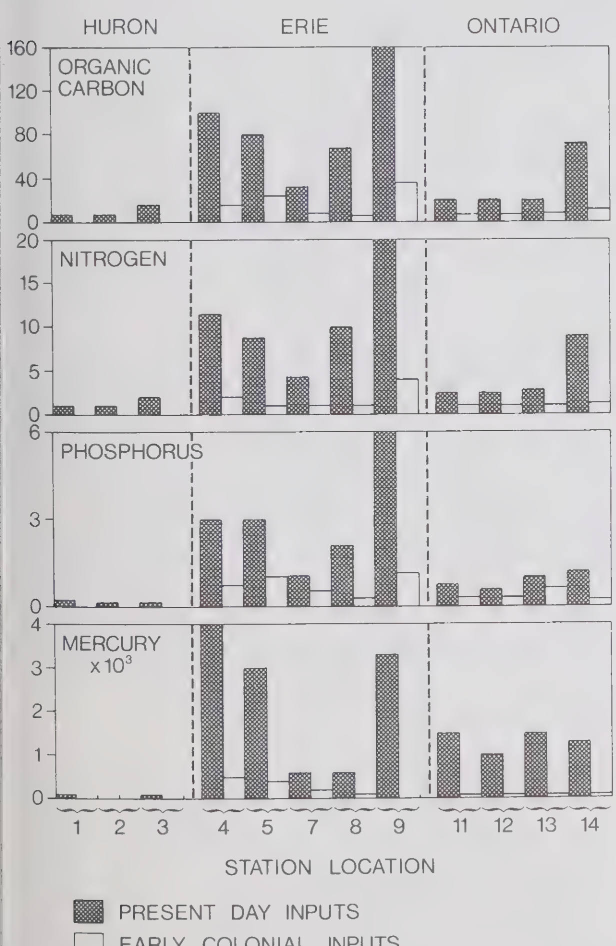
Fifty sediment samples were taken in the area of t outfall for analysis of carbon, carbohydrates and lignir There was no visible sign of fiber beds in this high ener nearshore zone.

Sedimentation Rates and Geochemical Inputs to Gre Lakes Sediments

Present-day sedimentation rates were determined f 14 core locations, representing basins of fine-grain

diment in Lakes Ontario, Erie and Huron. Present-day dimentation rates were estimated by averaging the weight sediment deposited above the *Castanea* (chestnut) pollen cline, dated 1930 for Lake Ontario and 1935 for Lake ie. Early-colonial sedimentation rates were estimated by eraging the weight of sediment deposited between the *stenea* horizon and the *Ambrosia* pollen rise, dated 1850. esent-day sedimentation rates were high in Lake Erie, nging from 847 to 5049 $gm^{-2}yr^{-1}$, low to intermediate in ke Ontario, ranging from 366 to 1156 $gm^{-2}yr^{-1}$ and low Lake Huron ranging from 147 to 325 $gm^{-2}yr^{-1}$. The sults show that there has been a three-fold increase in dimentation rate in Lake Erie since 1935 and the ngston basin of Lake Ontario since 1930.

The nutrient and Hg concentrations are enriched at the diment surface in all the cores from Lakes Ontario and ie, while the Huron cores show little change at the rface from their background concentrations. The en-chments are attributed to increased nutrient and Hg ading to the Ontario and Erie sediments, with the major creases after about 1950. The present-day loading of trients and Hg to the sediment parallels the rates of



gure 14. **A comparison of present-day and early-colonial inputs of organic carbon, nitrogen, phosphorus and mercury to the sediments of Lakes Ontario, Erie and Huron.**

sedimentation at each location, being greatest in Lake Erie. Early-colonial loading of nutrients and Hg to Lakes Ontario and Erie are generally similar to the modern loading of Lake Huron (Fig. 14). The total loading of sediment, nutrients and Hg was estimated for each lake. Present-day sediment accumulation of 4,600, 23,400 and 3,900 thousands of metric tons was estimated for Lakes Ontario, Erie and Huron respectively.

Sediment Organic Matter Studies

The fine-grained surface sediments of Lake Ontario contain 49 to 55 percent of the total nitrogen as insoluble combined amino acids and amino sugars. About 38-44 percent of the total nitrogen is in the form of unknown organic nitrogen compounds. Less than one percent of the total amino acids are present in the interstitial waters as free and soluble combined amino acids. The sediments appear to contain intact protein or peptide chains, little different to those found in Lake Ontario plankton samples. Ethanolamine, urea, asparagine, glutamine and citrulline were also characterized in the sediments, accounting for less than one percent of the total nitrogen.

The free amino acids released by the proteolytic enzyme pronase were determined on humic and fulvic acid and interstitial water extracts from Lakes Ontario and Erie surface sediment samples and zooplankton. The enzyme showed the same specificity towards the sediment organic matter extracts as towards casein, providing direct evidence for the occurrence of peptide bonds in the sediment organic matter. The lability of the organic matter extracts towards pronase hydrolysis followed the order: Interstitial waters $\approx$ zooplankton $>$ fulvic acids $\gg$ humic acids. No amino acids were released from fresh sediment by pronase hydrolysis, suggesting that in situ sediment organic matter is inert towards enzymatic cleavage by pronase. Further experiments suggested that the inhibition of enzyme activity in the sediment is due to the presence of sediment-humic acids.

Palynological and Geological Accomplishments of the Geological Survey of Canada Detachment

Pollen analyses were carried out on a long core from central Lake Erie to provide the necessary chronologic framework for paleomagnetic and oxygen and carbon isotope studies performed on the same core. Paleomagnetic analyses were carried out by Prof. Creer, University of Edinburgh, U.K. Profs. P. Fritz and S. Poplawski, University of Waterloo, completed a Geological Survey contract study on this core and submitted a report and O^{18} and C^{13} determinations on molluscan identifications.

About 40 piston cores collected from Lake Ontario during previous years' cruises were opened and the sediments were logged and described in detail.

Two pollen diagrams were prepared and plant macrofossil, mollusc and ostracode extractions are near completion on a buried peat layer from Lake Huron. Radiocarbon dates of 9,370 and 8,830 years B.P. were obtained at the base and top of the peat, respectively.

A piston coring and echo-sounding cruise was successfully carried out on Georgian Bay from October 22 -

November 1, 1973. Of particular interest was the discovery of a buried peat layer in Hope Bay confirming extremely low water levels in Georgian Bay.

Impacts and Pathways Section

The major research effort of this section has been a multi-disciplinary study of nutrient dynamics at the Bay of Quinte. The project attracted cooperative researchers from the Universities of British Columbia, Guelph, and Toronto. Important contributions to the project were made by staff of the Technical Operations Section (Scientific Operations Division) and Engineering (Scientific Support Division).

Other projects of the section include evaluation of certain gas chromatography techniques, chemical and biochemical research on PCB's, study of the environmental impact of non-ionic detergents, and oil-water studies.

Bay of Quinte Studies

The fields of study included gas transport (O_2, CO_2, N_2), sedimentology, geochemistry, nutrient kinetics, biology, and bioenergetics. The aim was to develop a flow diagram for the flux rates of carbon, nitrogen, phosphorus and, to a lesser degree, trace elements, and to assess the effect of various nutrient enrichments on productivity and species composition.

Certain compartments of carbon, nitrogen and phosphorus were monitored in an ecosystem contained in 3 limnocorrals situated in 4 M of water in the Bay of Quinte. These were triangular shaped having 25 feet on each side and extending from the surface to at least 2 feet into the rich sediments. Radioisotopes $^{32}P - PO_4$ and $^{14}C - HCO_3$ were added, and the rates at which they moved between the principal forms were monitored. One corral received no enrichment, another received PO_4 at a rate of 2.5 g/m^2/year, while the third was enriched with the same amount of PO_4 and NO_3 at a rate of 38 g/m^2/year.

The primary production, algal and zooplankton biomass and species composition were monitored and effects of nutrient enrichment noted. Relative uptake rates of ammonia and nitrate (using ^{15}N) were measured. The utilization of PO_4, HCO_3 were correlated to primary productivity, zooplankton grazing rates, and sedimentation rates. Bi-weekly sampling was continued for 3.5 months and still continues on approximately monthly intervals.

The role of bacteria in the utilization and recycling of nutrients is part of this study. Traditionally methods of determining the number (and subsequently biomass) of living cells have been by direct microscopic counts and by plate counts of viable cells. These methods are very time-consuming and subject to serious criticisms. Adenosine triphosphate (ATP) determinations are currently being used as a specific indicator of living microbial biomass. ATP is a high energy compound found in every living cell and it is used in all cellular activities. Many investigators have found there is a constant ratio between ATP and cell carbon in a variety of bacteria, algae, and zooplankton. The cellular ATP pool responds rapidly to changes in the metobolic activity of microorganisms. It is thought, therefore, that ATP will be a useful index of total living biomass for evaluating the effect of any environmental, nutritional, toxic variable.

Research was also begun to determine heterotrop uptake of dissolved organic compounds, dehydrogen and alkaline phosphatase. These parameters will be use indicators of bacterial metabolic activities and will correlated with ATP microbial biomass data.

The sedimentation rate was measured in the lim corrals by periodically collecting material caught in s ment traps. The sedimenting material was concentra with a high speed, flow-through centrifuge, freeze-dr weighed and stored for subsequent chemical and ra isotope analysis.

Lush growths of periphyton developed on the up most 2 M of each limnocorral. Quantitative samples of algal mat and its associated fauna were collected regul for chemical and radioisotope analysis. These data wil incorporated into C and P budgets and models and elucidate the effects of elevated surface to volume num in 'small' enclosure experiments.

The data obtained will be used to attempt to dev correlations between static measurements of biomass rate processes to be used in the development of models.

Gas Chromatography

The properties of Teflon, 30-60 mesh, as a comb support and stationary phase for liquid/solid gas chro tography were studied. Teflon columns have separa properties similar to porous polymer supports, giving s retention times at low operating temperatures. They suitable for the gas chromatography of polar org compounds in aqueous or organic solutions.

Polychlorinated Biphenyls (PCB's)

The optical properties of polychlorinated biphe (PCB's) were investigated. Commercial mixtures and res samples comprise approximately one hundred indivi PCB isomers. These differ in their physical and chen nature and in their physiological effects. A total of nir the major and additional ten of the minor constituent three common mixtures have been predicted to exi environmentally stable optical atropisomers. This fa regarded to have major influence on the biocher activities and biodegradation of those antipodes. presence of optical isomers of these ubiquitous con inants appears to have been hitherto neglected.

Bacterial Degradation Studies

It has been found that several bacterial species lake sediments can use lower percent chlorinatio polychlorinated biphenyls (PCB 1221 and PCB 1242 not higher chlorinated PCB (1254) as sole carbon energy source for growth. The major metabolic proc identified by the combined gas chromatographic and spectrophotometric techniques are exclusively aliphati aromatic hydrocarbons. None of the metabolites cont any chlorine.

vironmental Impact of Nonionic Detergents

Nonionic surfactants are used in household detergents d industrial cleaners, and for deresinification in the pulp d paper industry. While total Canadian consumption of nionic surfactants is difficult to determine, 15 to 20 llion pounds per year is a reasonable estimate. In this ht, a study to examine the biodegradability of these ostances under laboratory and field conditions and to aluate their environmental impact in lakes, has recently en initiated.

'-Water Studies

Material balances suggest that present input of bene-extractable materials in Burlington Bay is about an der of magnitude lower than that reported in 1969.

Our laboratory data indicate that in spills of crude oils d residual fuels, especially at low temperatures, the mation of water-in-oil emulsions requires low mixing ensities, i.e., that their appearance in such spills should expected.

A survey of initial evaporation rates from thin oil slicks owed a dependence on oil thickness. Thin crude oil layers re found to lose their gasoline fraction in the first few urs of exposure. An empirical relationship was developed the prediction of losses during the first hour of posure as a function of temperature, wind velocity, oil ckness, and oil type.

A gas-chromatographic method is being developed for imating light-end losses from crude oil, based on conutive G.C. analyses of fresh and aged oil samples.

Recommendations have been prepared for the Envimental Emergencies Handbook of Environment Canada the use of oil herding materials in oil spill accidents. This an outline of the oil herders' effectiveness, limitations, d promising areas of application. Their limited use is couraged in some specific oil spill situations for a fair ting of their performance and for the field experience in ir use.

Cooperative efforts have continued with the Envimental Protection Service unit at CCIW and the Water ences Subdivision (Ottawa) in joint projects and in the luation of outside projects and spill control materials d techniques.

GEOPHYSICAL LIMNOLOGY SUBDIVISION

The subdivision carries out research on the geology and ysics of lake systems as a fundamental framework in ich valid interpretation can be made of lake water mistry and associated biological response.

The two Sections, comprising the subdivision, conued their major research thrusts but in addition were ply involved in studies under the Canada/U.S. Agreent of 1972 and the International Joint Commission erences on the Upper Great Lakes and Studies of ironmental impact of dredging. These studies involved iment sampling and coring in Lakes Superior and orgian Bay, physical processes in the nearshore zone as they relate to waste heat and the characteristics of dredged sediment.

In addition, 1973 saw the development of a study plan, under the I.J.C. Land Drainage Reference Group, to evaluate the impact of land use practice on the water quality of the Great Lakes. The involvement of the subdivision relates to studies to determine the impact of dissolved and particulate materials on the lakes. To this end, study plans are being formulated to conduct surveys, primarily geolocical and geochemical, on the derivation of nutrients, trace metals and persistent toxic compounds from shoreline erosion and river input in the Canadian Sector of the Great Lakes watershed.

Interaction of the Physical Limnology and Geolimnology Sections continued to evolve with joint programming being undertaken under the auspices of the CCIW Nearshore Task Force. A nearshore experimental site was selected, equipment and personnel requirements were formulated to commence a long term study of the action of breaking waves and associated physical processes on shallow water and beach sediment.

Geolimnology Section

Regional Sedimentology and Geochemistry

During 1973 the Regional Sedimentology and Geochemistry programme completed sampling of the Great Lakes System (excluding Lake Michigan), with the grid sampling of Lake Superior and Georgian Bay.

During the field sampling, continuous low frequency echo-sounding profiles were run between sampling stations in order to map the distribution of sediment types. The sediment distribution derived from echo-sounding with sample analysis as control, is given for the Great Lakes in Figure 15. The distribution of sediment types in Lake Michigan was derived from previously published material and interpreted to conform with sediment classifications used in the remainder of the Great Lakes. Three major units, till and bedrock, glacio-lacustrine sediments and muds, together with major sand deposits are characterized and shown in Figure 15. The characteristics of each of the three units may be summarized as follows:

Till and Bedrock: Till and bedrock cannot be differentiated from sounding records. The tills, when recovered by sampling, vary in colour from medium gray to brown and are composed of cobbles and pebbles in a very stiff, silty clay matrix which may frequently be sandy. The tills are generally overlain by lag gravel deposits.

Glacio-lacustrine Sediments: The glacio-lacustrine sediments are dark gray to light brown silty clays occasionally sandy and enriched in calcium carbonate. They are moderately stiff and greasy, frequently laminated and occasionally contain ice rafted pebbles. In almost all cases, the glacio-lacustrine clays are overlain by a thin fine sand up to 6 cms thick. This sand is believed to have originated as a lag deposit formed by the winnowing of the fine materials from the surface of the deposit by current and wave activity.

Mud: The muds are generally located in the offshore deeper

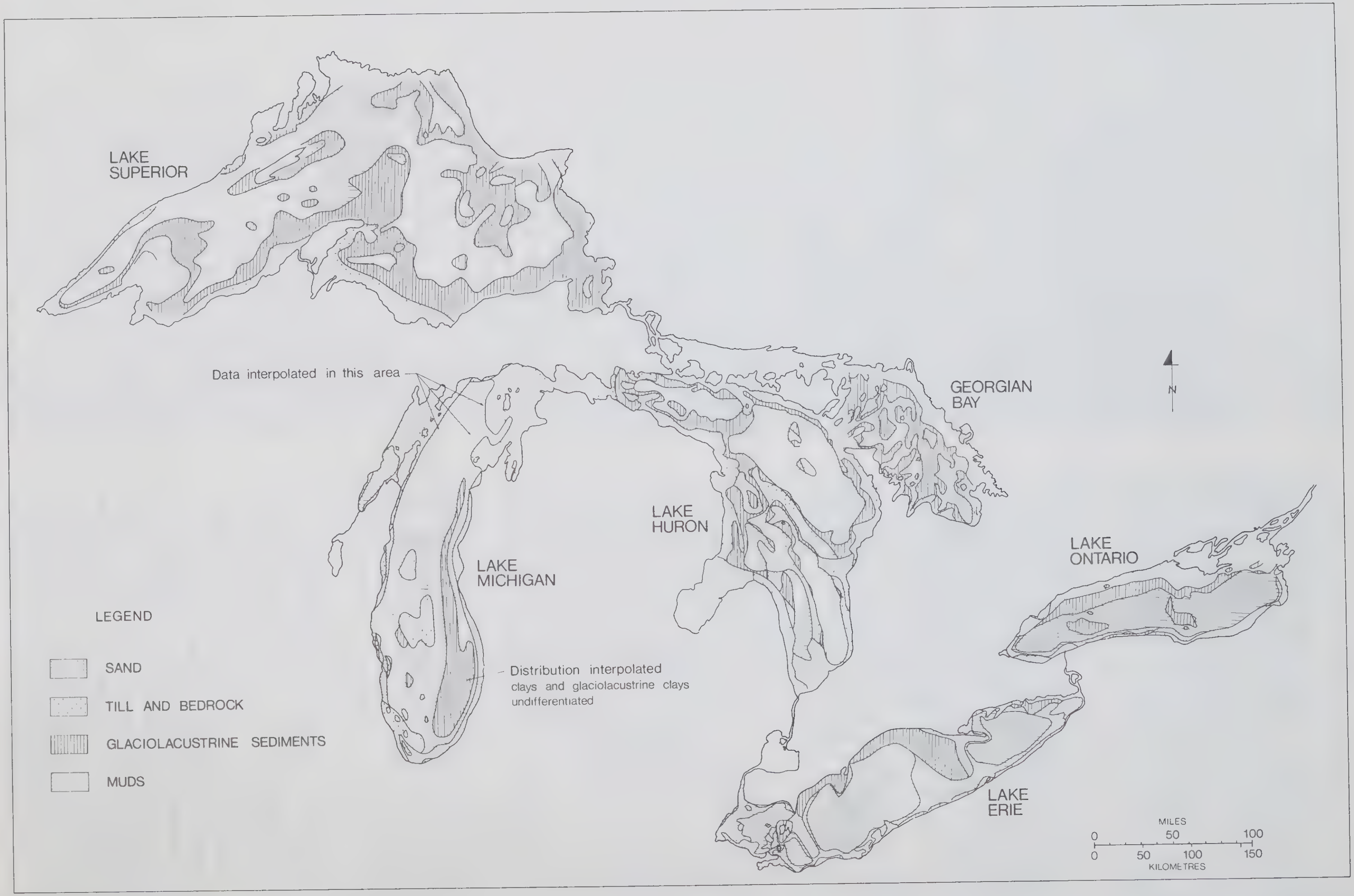


Figure 15. The Great Lakes bottom sediment distribution.

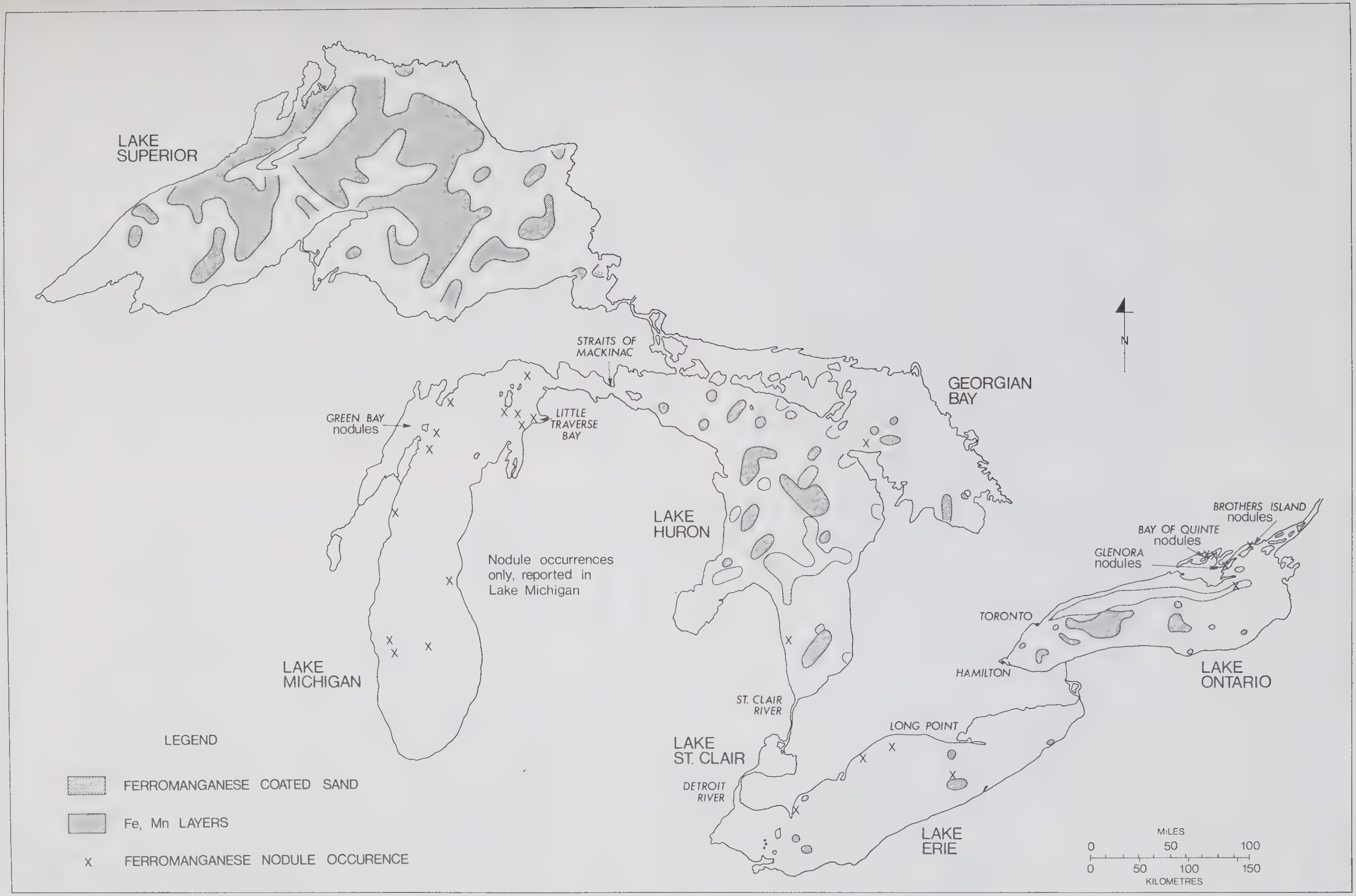


Figure 16. Occurrence of ferromanganese nodules, coated sands and Fe, Mn layers.

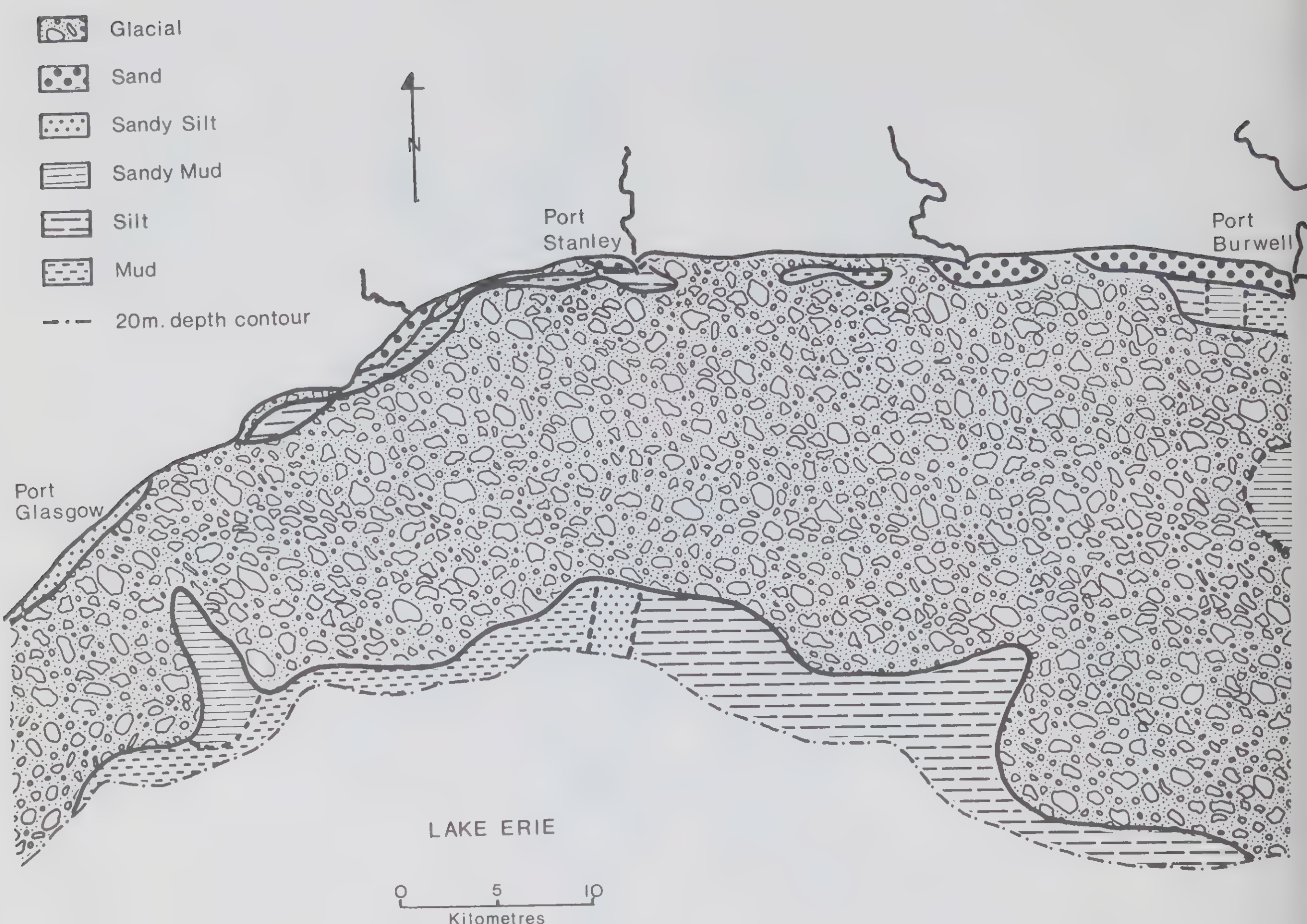


Figure 17. Map of sediment distribution, Port Burwell to Port Glasgow.

water areas of the lakes. They consist of soft, fluid, fine-grained silty clays and clays, gray to gray black in colour. In Lake Superior the muds are much firmer and lighter in colour due to slower rates of sedimentation. A distinctive feature, often observed in the lake muds, is a thin hard crust of yellowish-brown amorphous iron oxide. At some locations, the layer shows a segregation into a black manganese layer overlaying a yellow-brown layer.

The distribution of sediments containing the iron manganese layers together with ferromanganese coated sands and discreet nodule occurrences in the Great Lakes is summarized in Figure 16.

Additional sediment surveys were carried out in the Bay of Quinte, Lake Ontario, to determine the regional sediment distribution and chemical composition. Sampling of the region was completed during the year and the analyses for particle grain size, major and trace elements are nearing completion. This programme in the Bay of Quinte is being undertaken as a part of ongoing biological and chemical studies being undertaken by the division and the Great Lakes Biolimnology Laboratory.

Nearshore Studies

The 1973 Nearshore Sediment Inventory Programme extended coverage of the Lake Erie nearshore zone from Port Burwell to Port Glasgow, Lake Erie, Ontario. Pr liminary results indicate that surficial sediments are 80 glacial drift and associated lag deposits and 20% mode sediment (Figure 17).

The glacial material forms a broad offshore terrace th extends the length of the study area. Samples recover from the drift surface are typically pebbly clay tills a sandy gravel lag sediments.

Modern sediments, derived from the erosion of sho bluffs and offshore glacial drift, occur along the shoreli and at the lakeward limit of the zone. In the compl inshore area, sand accumulates alongshore behind artific obstructions and sandy silts; sandy muds, silts and mu occur in small discontinuous deposits further lakewa Preferential accumulation of sand on the west side harbour entrances throughout the area indicates net ea ward drift in the littoral zone. The offshore sedime consist primarily of silts and muds with a notable incre in clay content towards the west. This suggests that o the eastern portion of the deposit receives sufficient ene to prevent deposition of clay-size sediment or to remov after deposition by reworking. An examination of lakew circulation models reveals that there is, in fact, an area low current velocities corresponding to the higher c

›ncentrations found at the western end of the offshore ›posit.

The Nearshore Jetting Programme determines the ›ickness and basal material of nearshore sediment deposits. › 1973 surveys were carried out in four deposits in eastern ›ake Erie. Maximum thicknesses measured in the Fort Erie-›oint Abino, Mohawk Point, Long Point Bay, and Long ›oint-Erie deposits were 4.5 m., 5.5 m., 11 m., and ›5 m., respectively. The underlying material was mainly ›edrock east of Port Colborne and glacial sediment west of ›ort Colborne.

Coring operations based on a modified Beachcor ›ydraulic corer were carried out in nearshore Lake Ontario › Burlington and Niagara. Maximum recovery was 103 cm. ›ores are currently being analysed for pollen content to ›etermine whether pollen dating is applicable to sandy ›earshore sediments.

›ediment Data Archive (SEDATA)

1973 saw the installation at CCIW of a computer-based ›orage and retrieval system for sediment data collected in ›d around Canadian Lakes. The sediment data archive ›EDATA) uses the SAFRAS system obtained under ›cense from the University of Western Ontario and is ›pable of flexible input of unformatted data and selective ›trieval merging and editing of files. File building is ›mmencing and eventually will comprise records on more ›an 10,000 sediment samples and observations.

›ediment Transport Tracers

Tracer experiments were carried out off Confederation ›rk, Burlington Bar, Lake Ontario, during summer 1973 to ›omplement those of fall 1972. The tracer medium was a ›nthetic glass sand with 3.4% antimony (Sb) as the tag. ›eliminary examination of the tracer patterns indicates ›at the summer months are characterized by conditions of ›ttle net movement at the depth of tracer injection, Figure ›8, due to general lack of significant storms and the ›olating effect on the bottom caused by annual peak water ›vels. Contemporaneous monitoring of beach zone bottom ›ofiles indicates that accretion was dominant during this ›eriod.

›reat Lakes Shore Erosion Summary

This project, undertaken by Lakes Research Division, ›rmed part of the joint Canada/Ontario Great Lakes Shore ›amage Survey, described elsewhere under the report of ›e Shore Properties Section of the Marine Sciences ›irectorate. Its objective is to determine, using existing ›LLB data and historical aerial photographs and land ›rveyors records, the long-term rate of erosion along the ›odible shorelines of the Great Lakes. Data gathering is in ›ogress and the results will be included in the coastal zone ›las scheduled for completion in mid-1974. The results of ›e project contribute greatly to classification of the ›oreline based on erodibility and delineating areas of ›normal erosion for more in-depth investigations.

›eistocene and Holocene Stratigraphy of the Laurentian ›reat Lakes

A new project initiated this year had as its objective a study of the stratigraphy of Great Lakes sediments. This research will not only provide information on the history of the Great Lakes but also will, through a study of the various sedimentary processes that have taken place in the past, lead to a more precise interpretation of present-day sediment characteristics and distributions.

Field work this year was concentrated on Lake Superior, particularly the northern part. During two cruises on the M/V MARTIN KARLSEN, 60 gravity and piston cores ranging in length up to 18 metres were collected. Preliminary logging of these cores show that many have penetrated to till and thus will provide a complete record of sedimentation in Lake Superior during the last 11,000 years. Overlying the till is a sequence of red and gray varved clays deposited in late-glacial time and these are overlain by post-glacial fine-grained gray and brown silty clays. Detailed stratigraphic, mineralogical and palynological studies of these cores are being undertaken.

Other research on Great Lakes stratigraphy carried out in collaboration with Geological Survey of Canada personnel involved a study of a nine metre piston core from South Bay, Manitoulin Island, and a series of cores penetrating a buried gravel bar at the western end of Lake Ontario. The South Bay core provides a complete record of sedimentation from late-glacial to the present time and is particularly interesting in that it contains two organic layers indicating former low level stages. Shells and peat from these layers are being dated by C-14 methods. Organic matter associated with the gravel bar in Lake Ontario is also being dated.

In addition to providing information on sedimentological processes and lake history, sediment studies can disclose

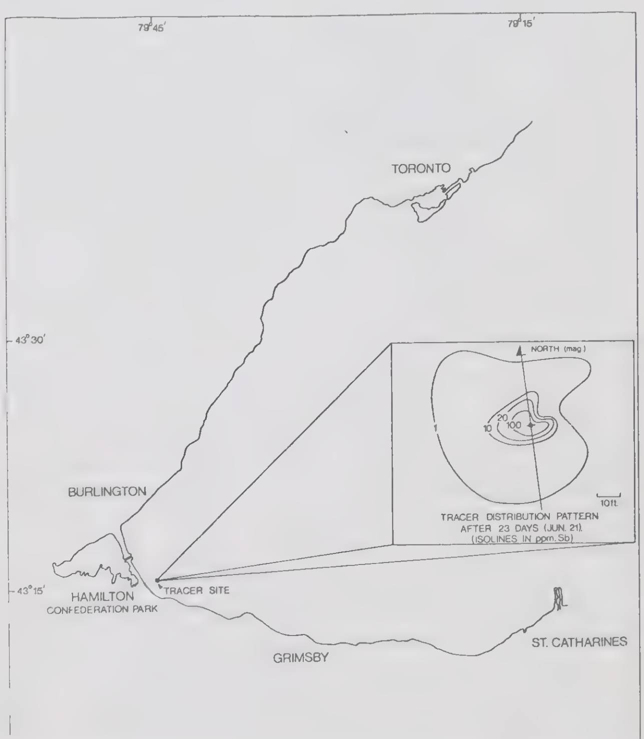


Figure 18. Sediment tracer experiments, western Lake Ontario, 1973.

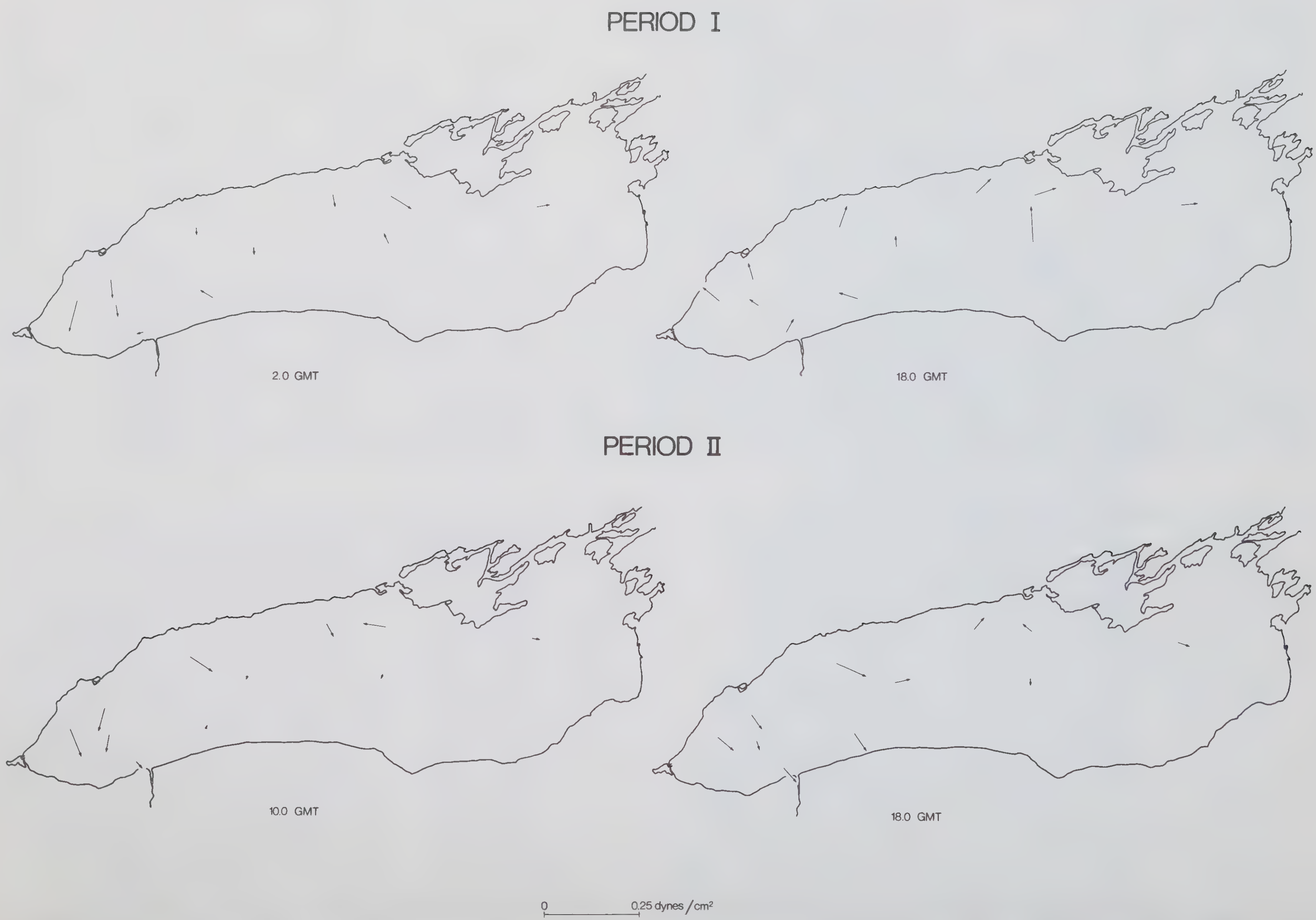


Figure 19. Resultant wind stress vectors averaged for the hours shown during the periods April 18 to May 18, and from May 29 to June 27, 1972.

e presence of minerals related to chemical processes in a ke. In this regard, of special interest was the identification the phosphate mineral, vivianite, which was found in nall nodules, crystal clusters, and irregular masses in st-glacial clayey sediments from Lakes Superior, Erie and ntario. This mineral has formed authigenically within the diment and is thus related to the phosphorus cycle in ese lakes.

ngineering Geology

In November, an Engineering Geologist joined the staff carry out geotechnical evaluation of lacustrine and oreline sediments in connection with research activities of e section.

Priority was given to the set up and establishment of boratory equipment needed for soil mechanics' tests. ost of this equipment is presently operational, and steps e taken to complete the development of more complex ting instruments.

Geotechnical properties of offshore surficial sediments ll be investigated in connection with the characterization contaminated dredged materials for their potential use as ndfills. Studies are being conducted to determine the fluence of mineralogical composition, organic matter, and norphous constituents upon compressibility, plasticity, rmeability, and shear strength.

Geotechnical properties of onshore Pleistocene and cent sediments will be investigated in relation to their bility and erodibility with the aim to determine the uses of abnormally high erosion rates.

The shoreline erosion studies being conducted jointly th the Civil Engineering Department of the University of terloo, were continued throughout the year and a final port on this activity is currently being prepared.

eoenvironmental Studies

The Paleoenvironmental Research Group of the Water sources Detachment arrived in Ontario on June 1, 1973 d took up occupancy at the Canada Centre for Inland ters at the beginning of July.

The months of June, July and August were spent in the y of Quinte area, undertaking a survey of shelled ertebrates (Ostracodes and Molluscs) and of the water ality of the environments in which the shelled inverte- tes were found to live. The survey extended from nton to the Glenora Ferry, as well as including the north re of Lake Ontario, between Wellington and Point Petre luding West and East Lakes. The fauna were found to be rce in that part of Big Bay studied, however, empty lls were found to be abundant in many local areas.

In conjunction with Dr. J. Williams, CCIW, one metre es were obtained from Big Bay and the bay south of leville. The top half or two-thirds of the cores also ntained a reduced number of shelled invertebrate fauna. e causes of this reduction are under investigation.

ysical Limnology Section

rm Surge Studies and Model Verification

An extensive analysis of the International Field Year data was undertaken in 1973. In a study with F. C. Elder of the wind stress field over Lake Ontario, a number of features influencing the dynamics of water circulation were noted. One such feature is the land-lake breeze system. Daily oscillations in the strength and direction of stress field averaged over two periods, April 18 to May 18 and from May 29 to June 27, 1972, are shown in Figure 19. Relatively large daily fluctuations in the current may be produced by such a wind field.

A method was developed for determining the phase relations and correlations between vector time series. In an application of the technique to lake modelling, an analysis of isotherm fluctuations and current fluctuation at IFYGL station number six, shows that the long period internal waves known as "inertial waves" satisfy simple mass continuity in the upper layer. Figure 20b shows the high correlation, C^-, at the inertial period and in 20a the associated phase reversal, ($\bar{\phi}^- = 180^\circ$). The phase relation may be interpreted to mean that the epilimnion thickness is largest when the clockwise rotating "inertial" current vectors have just completed half a cycle of onshore motion.

Finally, some results from the storm surge investigation are given in Figure 21 for the Belle River station on the southeastern shore of Lake St. Clair. The line which is derived by regression analysis for six storms during the fall and winter relates wind speed squared resolved in a northerly direction to the predicted storm surge. These curves were prepared by W. P. Budgell of MSD for the purpose of forecasting storm warnings in the Lake St. Clair area.

Hydrodynamic Modelling

In the area of computer simulation of lake circulations, a variety of problems were considered during the year. Of primary importance in this regard, is the model verification study that is being carried out in the framework of the 1972 Field Year on Lake Ontario. A number of significant physical episodes were selected from the field data and a three-dimensional numerical model was used in an attempt to simulate the behaviour of the lake during these episodes. These studies show that models based on conventional hydrodynamic concepts are quite successful during periods of relatively weak stratification. Initial results however, indicate somewhat less satisfactory performance for the summer months, most likely due to the low vertical resolution of the lake models presently in use.

With regard to long-term operation of the lake circulation model, a preliminary feasibility study was undertaken consisting of a continuous computation for the 1970 shipping season on Lake Erie. Using the Buffalo-minus-Toledo water levels as an indicator of the model performance, the experiment was an unqualified success, the correlation coefficient between observed and computed wind set-up averaging out to .90 for the nine months of operation. This study was carried out in the framework of the interdisciplinary modelling programme at CCIW, and the computed lake circulations are combined with data from ship cruises in order to study the distribution of chemical parameters in the Great Lakes.

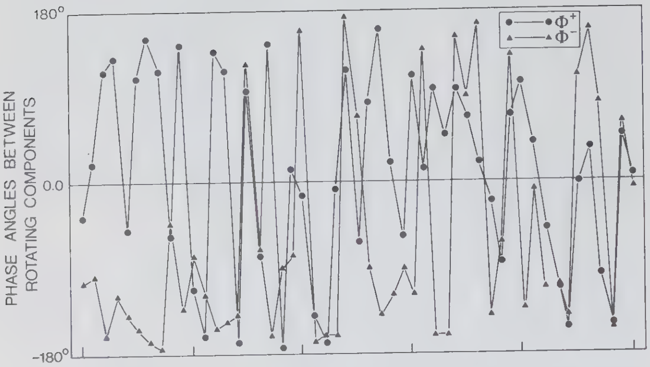


Figure 20a. Phase angles between the thermocline displacement and upper layer currents for each of the two oppositely rotating components.

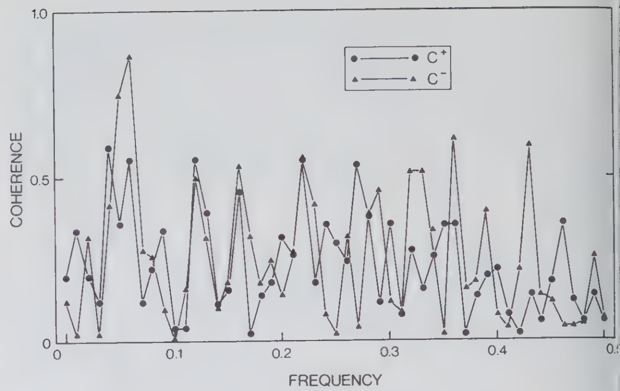


Figure 20b. Coherences between the thermocline displacement a current at station 6 for each of the two rotati components.

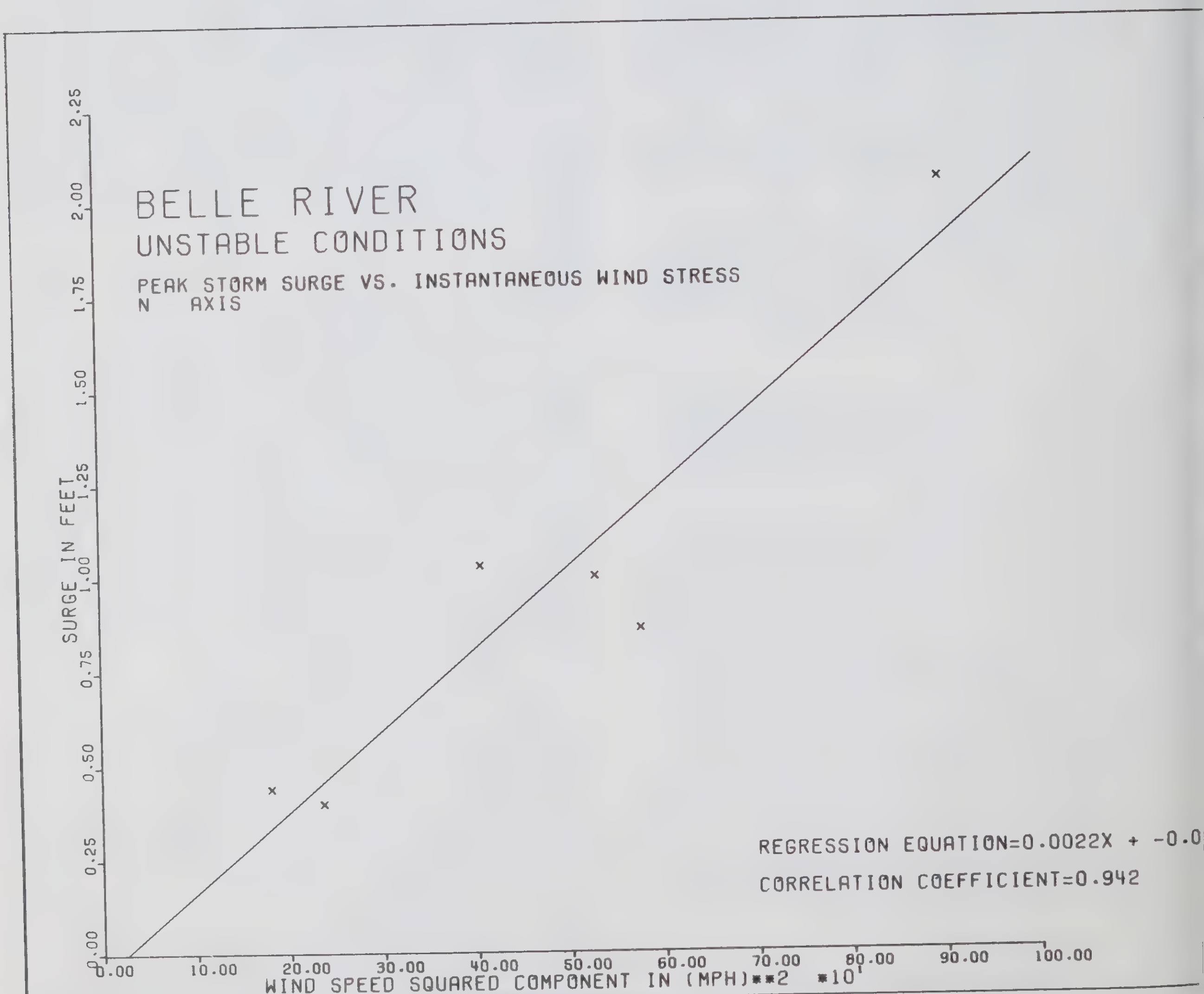


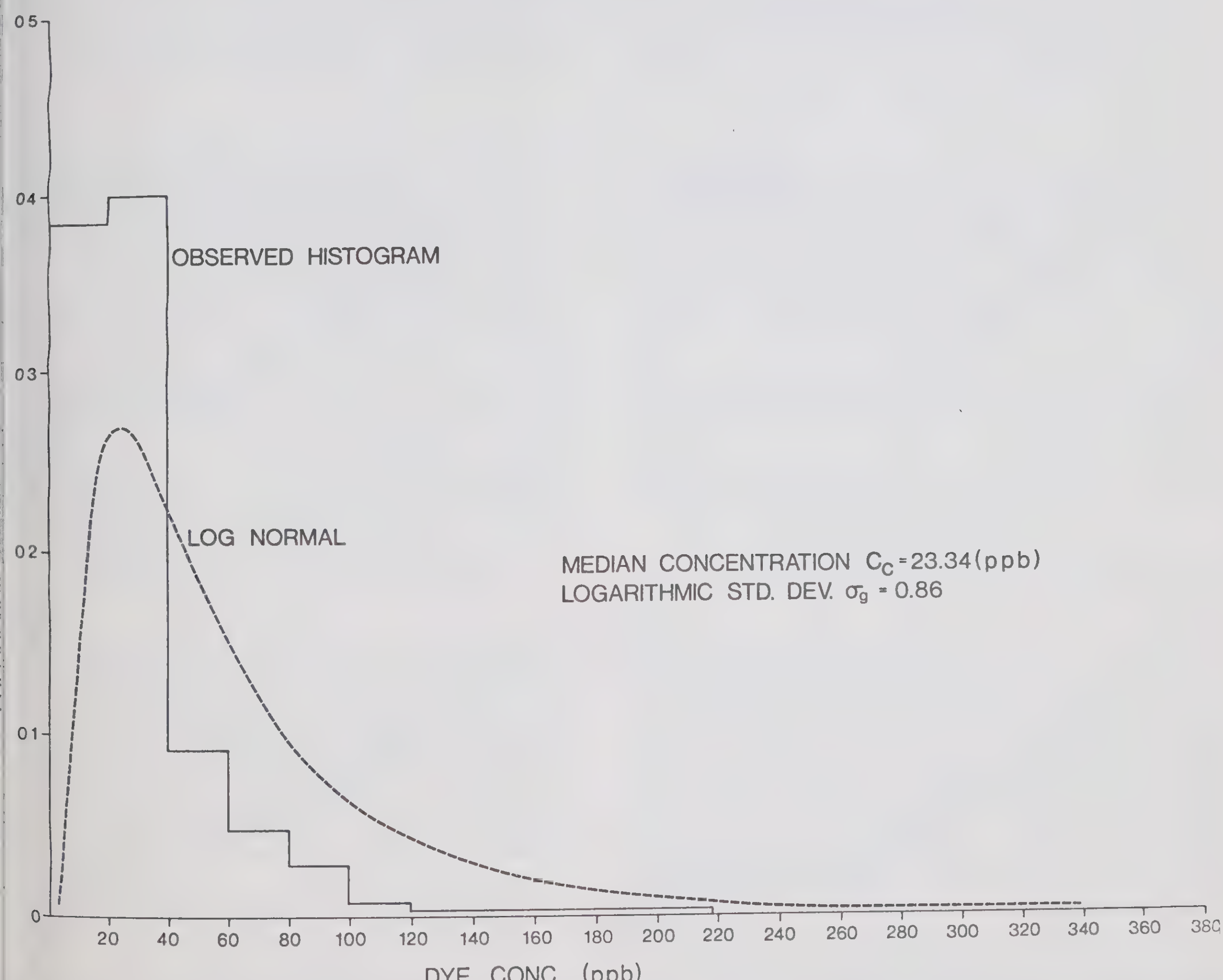
Figure 21. Peak water level surge plotted as a function of the instantaneous wind speed squared along the north direction, unstable stabil

Among further applications of computer simulation nniques, CCIW staff members collaborated with the rine Sciences Directorate, Ottawa, in preparing a film, ich graphically depicts the spread and movement of oil ls that could occur near proposed ports on the east and st coasts. The film was produced by photographing put from the CCIW computer on a cathode-ray tube, ile running models developed by MSD for areas in the aits of Georgia, Bay of Fundy and Gulf of St. Lawrence. s anticipated that this form of visual display will find reasing application in data processing as well as model- projects.

fusion/Nearshore Physical Processes

The analysis of the experimental data from several fusion experiments carried out in Lake Ontario during YGL was completed. A number of diffusion diagrams wing the dependence of eddy diffusivities on the erved environmental parameters were constructed in h a way that they are useful for modelling practical diffusion problems. Such diffusion diagrams may be used to predict mean concentration distributions of diffusing substances in the lakes. However, from a biological standpoint, in order to assess the suitability of water mass as a medium for living organisms, the mean concentration field alone is inadequate. The variance of the concentration field, the magnitude and duration of the concentration peaks and the frequency of occurrence of concentration levels are all important parameters in order to assess the possible effects of the diffusing substance on living organisms. In order to predict these statistical parameters a complete knowledge of the probability distributions of concentrations are required. Experiments were designed to measure the concentration history at a fixed point in the wake of a continuous point source dye plume in coastal currents of Lake Ontario. A preliminary analysis of the data suggests that the concentration probabilities fit the Logarithmico-normal distribution (Figure 22).

Further study is planned to develop a statistical model to predict statistical parameters of interest to assess the quality of water masses.



ure 22. Fitted log-normal distribution to observed concentrations at a fixed point in the wake of a continuous point source in coastal currents.

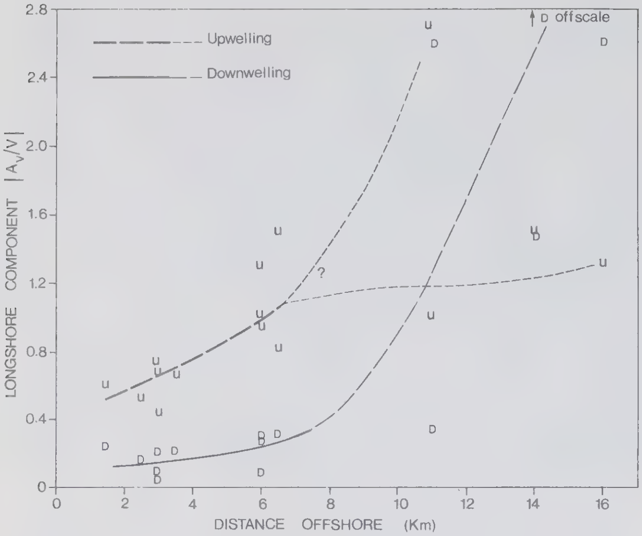


Figure 23. A plot of the ratio of the amplitude, A_V of rotary (periods near 17 hours) currents relative to the mean flow, V, versus distance offshore during upwelling (U) and downwelling (D) of the thermocline. Note the abrupt increase of A_V/V at distances of 8 km offshore and greater.

Summary of Findings on Nearshore Circulation

After processing most of the current meter da obtained in 1970 and 1972 off Oshawa in Lake Ontario, has been found that the horizontal circulation nearsho within 8 or 10 km of the coast has distinct characteristic If one compares the intensity of rotary wavelike curren (periodicities of near 17 hours) with the mean curre during distinct periods when the thermocline is eith downwelled or upwelled, the amplitudes of the wave-li currents are seen to be relatively small until about 8 k offshore where the intensity increases abruptly (Figure 23 Within this zone, the "wave"* intensity relative to t mean alongshore flow is lower during downwelling of t thermocline. These characteristics and the physical pr cesses responsible for them will be studied during the ne year. Upwelling and downwelling of the thermocline usually confined to the same nearshore zone within 8 km the coast as indicated by representative profiles of temper ture across the nearshore zone off Oshawa (Figs. 24a, 24 24c and 24d). Data were obtained under contract by t University of Waterloo.

*17-hour currents rotating clockwise.

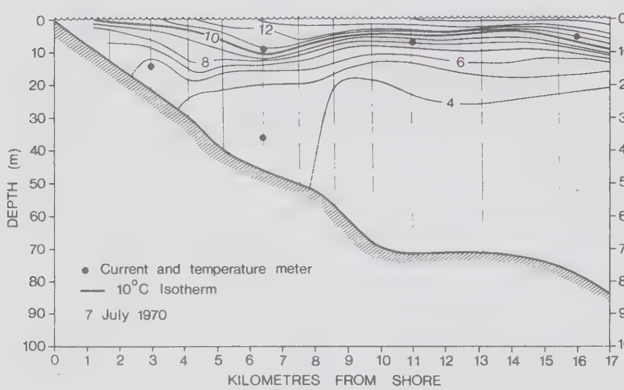


Figure 24a. Upwelled thermoclines nearshore.

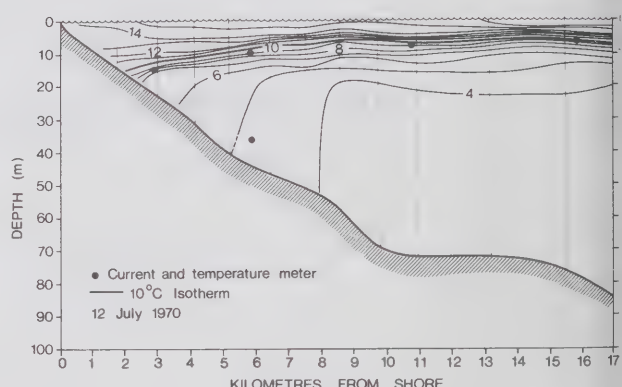


Figure 24b. Downwelled thermoclines nearshore.

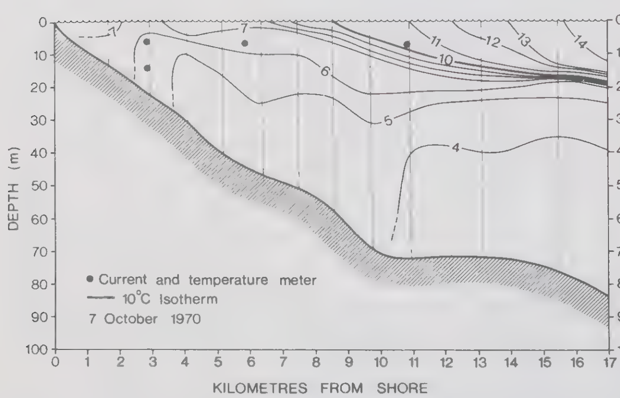


Figure 24c. Upwelled thermoclines nearshore.

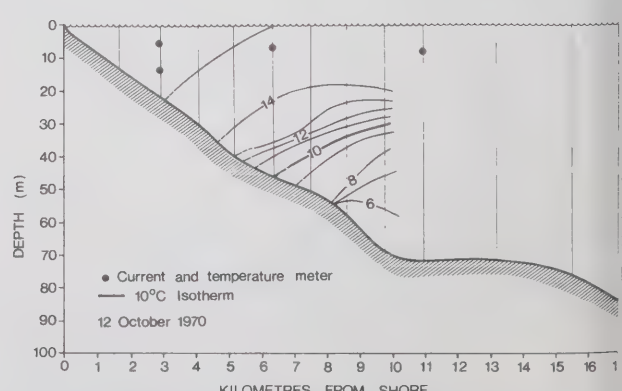
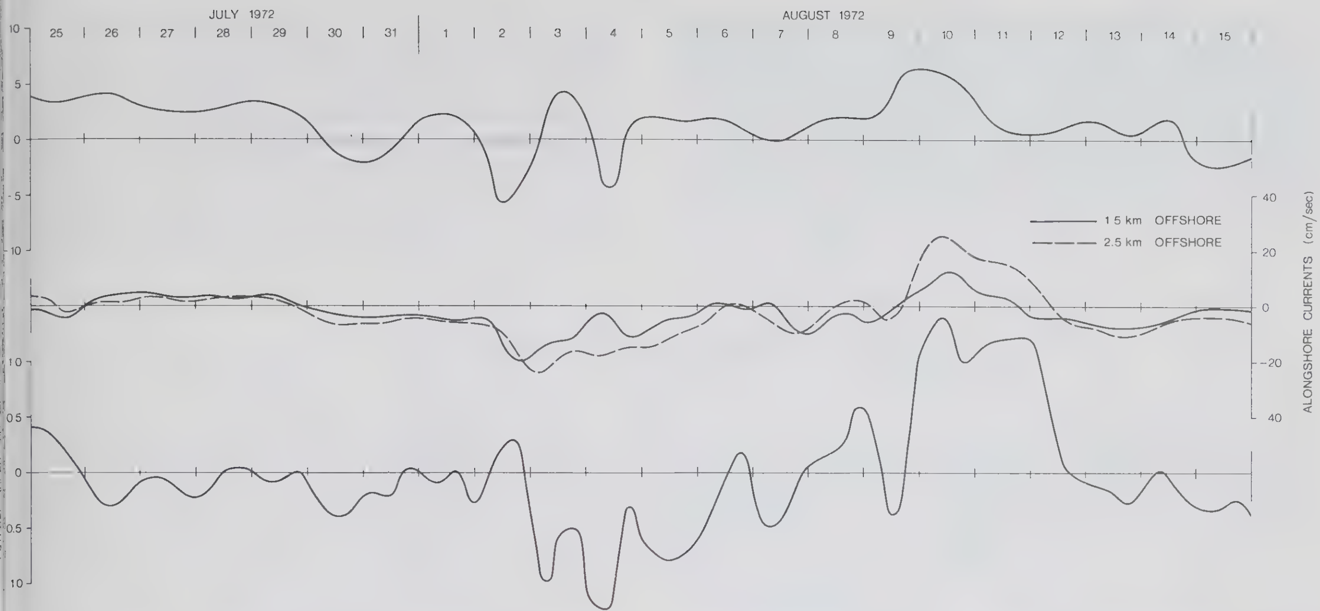


Figure 24d. Downwelled thermoclines nearshore.



gure 25. Lateral shear versus time as computed from the alongshore currents at two meters in the nearshore zone. Note the large values of lateral shear measured after the wind drops and reverses.

Observations of the horizontal currents across the arshore zone indicate that reversals in the direction of ongshore currents are accompanied by large differences in e speeds at various distances offshore. An examination several episodes of reversing currents (Figure 25) reveals at large lateral shears** occur with frequencies approximately equal to those of the large weather systems passing rough the area. As the wind-driven alongshore currents arshore are decelerated and reversed by reversing winds, is often observed that plumes of dye and suspended aterials are rapidly dispersed. It is believed that the large ue of lateral shear observed during current reversals are ponsible for the observed rapid dispersion. During olonged steady winds, when alongshore currents may be ite fast, lateral shear in the nearshore zone is usually low d the accompanying dispersion of suspended and dissved material appears to be correspondingly low.

lculation of Lake Residence Time

After processing the temperature and outflow data tained from various sources for Okanagan Mainstem kes, both the distributions of outflow and lake-wide mperature for selected depths over a seasonal cycle were termined. It was found that the magnitudes of outflow, d stratification and variation in time and space, had nificant effect on the retention of original water mass for lake as compared to the equivalent non-stratified condion.

The average retention time of a lake was determined by lculating the moment arm (Figure 26):

$$R_{ave} = \frac{1}{V_0}\left[0.5\Delta V_1 + 1.5\Delta V_2 + 2.5\Delta V_3 + \ldots + (t_n + 0.5)V_n\right]$$

where

R_{ave} denotes the average retention time of a lake, V_0 the initial volume of the lake and ΔV the change in volume of original waters. Subscripts 0, 1, 2, 3, . . . n, denote the time unit.

It was found that R_{ave} was related to the time over which 50% of the original lake volume is replenished. This time may be defined as the half-life:

$$V(t)/V_0 = 1/2, \text{ thus}$$

$$e^{-xt_h} = 1/2$$

where t_h denotes the half-life and x, the rate of export of water.

IFYGL Conclusion and Analysis

The IFYGL Heat Content Surveys continued into the spring of 1973 in order to complete one full year of data collection. During the balance of the year the data from this programme have been edited and computer programmes have been written for final analyses. Preliminary cruise reports were issued for all of the surveys. The final computation and report will be made in the next few months.

IFYGL Temperature Transect Data

Analysis of the temperature transects and water movement data obtained from the IFYGL cruises on Lake Ontario was advanced throughout the year.

**lateral shear = alongshore velocity differences at two points divided by distance separating the points.

Investigations were carried out on large-scale basin-wide diffusion phenomena. The results of this study are possibly significant in that they suggest that the mean concentration distribution of a conservative substance in the open lake can be explained as a diffusion process and that the horizontal mixing time scale of a typical G Lakes basin is of the order of a few months only.

Other investigations on the effect of stratificatior the residence time of lakes, and on the problem: similitude between vertical diffusion in limnocorrals ar

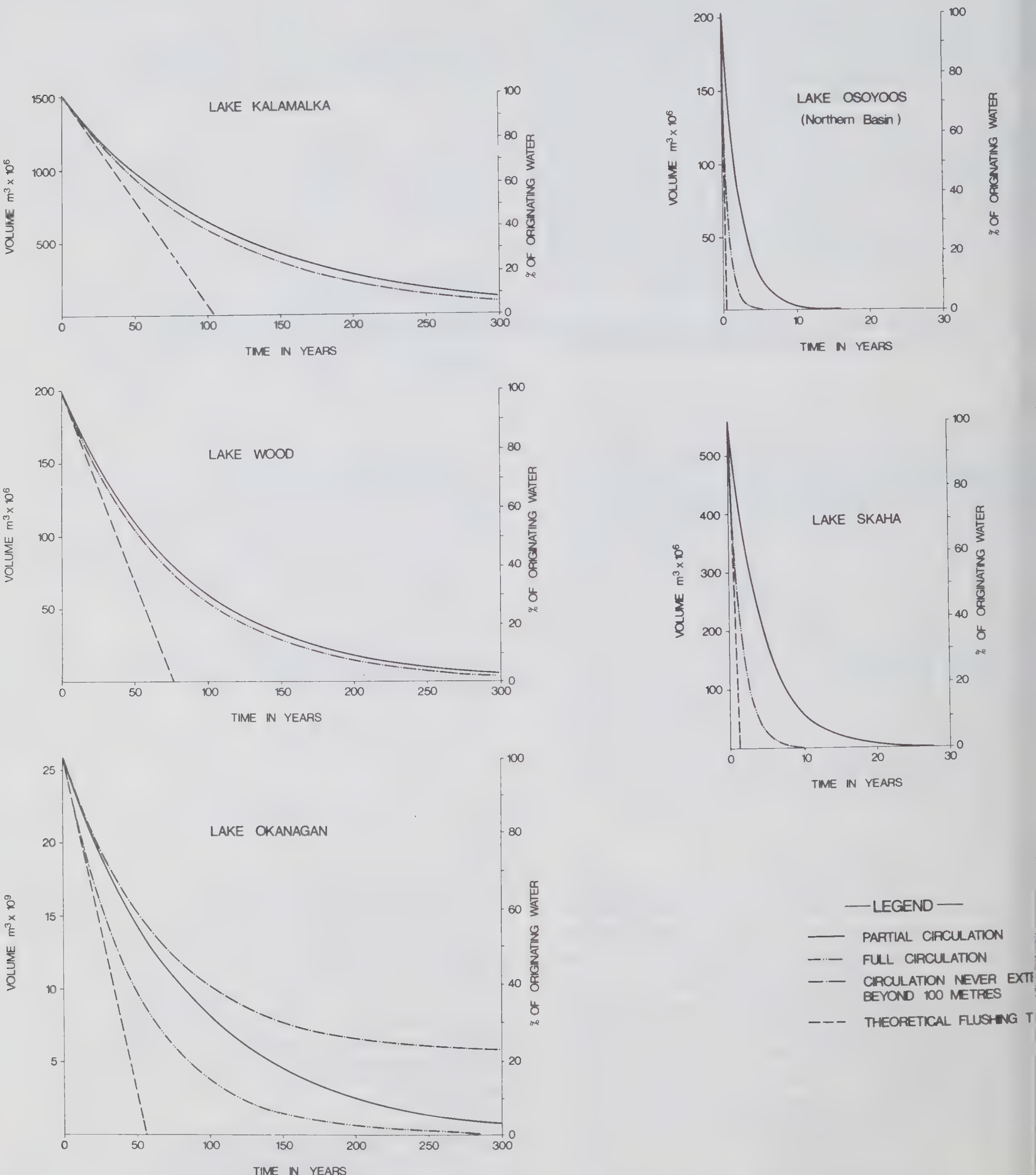


Figure 26. The retention of the original waters at the beginning of the first year of the Okanagan Mainstem Lakes.

open lake were completed.

e du Doré Programme

As part of a long-term research effort into the amics of the Great Lakes Coastal Zone, an array of ored instruments was established near Baie du Doré in e Huron. The array contained current meters, surface eorological packages, and fixed temperature profilers. The experiment also served to complement data collected by the University of Waterloo and Ontario Hydro. (The site is near the Bruce Nuclear Power Station). The Fixed Temperature Profiler system, which saw its first use during IFYGL and has since been improved, was further tested by this experiment and the basic design has proven to be viable in harsh field conditons. Analysis of the 1973 Baie du Doré data is in progress.

SCIENTIFIC OPERATIONS DIVISION

At the beginning of 1973, Scientific Operations Division D) was established as part of the CCIW-based organiza- of Inland Waters Directorate. Portions of both the es Research Division and the Scientific Support Division e brought together into this new Division to simplify management of the complexly interrelated scientific support activities of IWD at CCIW. The components of) (Microbiology Laboratories, Physical Sciences Labora- es, Remote Sensing, Technical Operations, and Data agement) are each, to differing degrees, characterized heir 3-fold functions of:

- providing services to many or virtually all of the other scientific organizations at CCIW
- conducting research and development studies related to the methodology of each Section
- conducting or participating in environmental research projects related to the specialization of each Section.

In addition, through the office of the Division Chief, e is considerable involvement in the planning and ction of multi-agency programmes of study concerning ctive management of lake systems.

sion Chief and Administration

In addition to the supervision and administration es pertaining to SOD, the Division Chief spent approxi- ely one-third of his time in functions related to nbership on various national and international com- tees. Most of this concerned his position as Canadian Chairman, International Joint Commission Upper Lakes erence Group. During 1973, the ULRG developed, and nmenced to implement, a multi-million dollar study of es Superior and Huron, involving five states, the vince of Ontario, as well as the U.S. and Canadian ernments, to be completed by the end of 1975.

Membership on a federal-provincial Lake Winnipeg er Quality Study Working Group had led, by the closing s of 1973, to the initial planning stages of a 3-year study ı.

robiological Laboratories

The Microbiology Laboratories have three main func- ns. One is to develop and evaluate microbiological, logical and mycological *methodology* and criteria for nitoring, assessing and maintaining water quality from the viewpoint of health hazards and eutrophication. This involves taking these techniques into the field and becoming involved in monitoring of international waters and participation in and development of microbiological programs in the Inland Waters Directorate water quality network.

The second function is *environmental research* and the thrusts of this function are, the establishment of the extent of a waste's (sewage, industrial waste, farm run-off) influence on water bodies and the rate of its degradation and the determination of the distribution of specific microorganisms and their roles in the aquatic ecosystem. Based on these studies of microorganism distribution and function, a National Culture Collection for lake organisms is being established.

The third function is to provide *technical microbiological, mycological and virological support* to inhouse, inter-service and provincial projects.

Coupled with these roles, and indirectly related, is the laboratories interest in evaluating microbial pollution of air (bacteria, fungi, and viruses) due to sewage treatment processes and the disposal of sewage wastes.

Because of these functions the Microbiological Laboratories, through their various units, were involved in many diverse areas in 1973. Some of these studies involved field work such as the International Joint Commission Studies on the St. Mary's River, St. Lawrence River, Lake Superior, Lake Erie and Lake Ontario, while in other instances samples were brought to the Laboratory for analyses from Bronte Creek Provincial Park, Welland Canal, Burlington Canal, and the Grand River.

Microbiology Laboratories staff were also involved in studies of (1) the relationship of fecal sterols to bacterial indicators, (2) assimilative capacity of Great Lakes waters, (3) the relationship of temperature and nutrient levels to bacterial multiplication, and (4) preservation techniques for bacterial cultures and preservation of water samples.

Staff also reviewed more than 15 grant applications, contract proposals and papers, monitored 7 contracts, and participated in a number of committees.

Methods Development and Technical Support

A year long joint study with the Ottawa EPS Bacteriological Laboratory and the Water Quality Division, Burlington on the Ottawa River, Grand River and the

Burlington Canal was completed during 1973. Water samples were collected weekly, daily and often twice daily and tested for nineteen different microbiological, chemical and physical factors in order to establish an ideal sampling frequency, sampling time, number of samples to be collected, parameters which should be tested for and the length of time water samples may be kept before analysis. Another study associated with this program was an investigation into the relationship of fecal sterols and bacteria, with findings indicating that no significant relationship exists between these two indicator systems for health aspects of water quality. However, fecal sterols were found to be ideal indicators of excretal contamination of industrial waste where bacteriological data is suggestive or doubtful and they could also be used as indicators of the efficiency of various sewage treatment processes.

A joint study with a commercial firm, a member of the Bureau of Fisheries, EPA, U.S.A. and our laboratories, on the efficiency of membrane filters in recovering bacteria from water, led to a paper which indicated great differences in various manufacturers 'membranes' ability to recover bacteria.

Twenty-four cores from Lake Erie and Lake Ontario were examined for twelve different bacterial populations, oxygen uptake rates and various chemical parameters in order to study the effect of landwash on sediment bacterial populations and to develop microbiological methods for examining sediments.

Upper Lakes Study

During May-November, 1973 the Water Quality Assessment Unit undertook an extensive microbiological survey of Lake Superior to obtain microbiological baseline data in order to develop criteria for non-degradative water quality standards as well as to establish health-oriented bacterial indicator systems for the Great Lakes. Special studies were made on 4 of these cruises to relate specific nutrient decomposition and recycling in the lake through enumeration of sulfur cycle and nitrogen cycle organisms.

The Lake Superior program involved a total of six cruises, covering approximately 1,800 miles on which an average of 353 water samples were collected at several depths and analysed for various bacteriological parameters (Table 1).

During our studies on the distribution of microbial species in Lake Superior, an interesting observation on bacterial activity at 4°C was noted. As shown in Figure 27 the rate of oxygen utilization of 4°C by an isolate (psychrophilic) from Lake Superior (*Flavobacterium Sp.*) was comparable to the rate of oxygen utilization by a river bacteria (mesophilic) at 20°C. This finding made it imperative to determine the temperature optima of these lake bacteria in order to understand their role in relation to temperature in the seasonal assimilative capacity of the lake. Chemostat studies are presently being carried out to establish growth rates of lake bacteria at different temperatures. Results of these studies will provide information on heterotrophic microbial productivity in relation to nutrient input in receiving waters.

Table 1. Lake Superior Sampling Program

Date	No. of Samples	Parameters Test
May	359	A B D F
June	373	A B C D
July-August	373	A B C E
September	379	A B C
October	307	A B C D
November	326	A C E
Total Number of Samples	2,117	
Average per Cruise	353	

A – Coliforms, Fecal Coliforms, Fecal Streptococcus, Bacte Biomass
B – *Pseudomonas Sp.*
C – Bacteria Showing Phosphatase activity
D – Organic Sulfur reducers, Thiobacillus, Desulfovibrio
E – Nitrifying, Denitrifying and Ammonifying bacteria and Azc acter
F – Nitrifying and Ammonifying bacteria

Microbiological Aspects of a Point Source Study on La Superior at Marathon, Ontario

To supplement the main lakes monitor progra Microbiology Laboratories participated in a joint mu disciplinary field study with Great Lakes Biolimnology a Lakes Research Division personnel on the impact industrial waste discharges from pulp and paper mills on t distribution of microbial species in the lake.

During the one week study, microbiology samples w collected at various depths from fixed stations as well stations within the daily varying plume flow. All samp were collected within a 2-square mile area adjacent Marathon, Ontario. Microbiological analyses were p formed on these samples to relate population levels of aero heterotrophs, *Desulfovibrio Sp.* and *Thiobacillus Sp.* relation to the available nutrients (paper mill wastes) that some understanding of the physiological effects of t waste material could be determined. Preliminary d analysis indicated a negative correlation between th bacteria and nitrogen, phosphorus and depth. No consiste trend was observed between the tested bacterial species a other chemical measurements.

Laboratory experiments, using a batch type ferment to examine biodegradation of Marathon paper mill was by bacteria collected from the Marathon sampling si indicated that approximately 78% of the wastes w degraded within 48 hours by the indigenous bacte species.

Microbial Taxonomy

Recent developments in computerized techniques applied to bacterial taxonomy, together with novel c cepts of classification, have overcome many of the pr lems encountered when attempts are made to clas bacteria isolated from natural environments. Techniq whereby the overall similarities of organisms are assess and subsequently classified on the bases of these si larities, appear ideally suited to the taxonomy of unique and often highly variable, bacteria commo

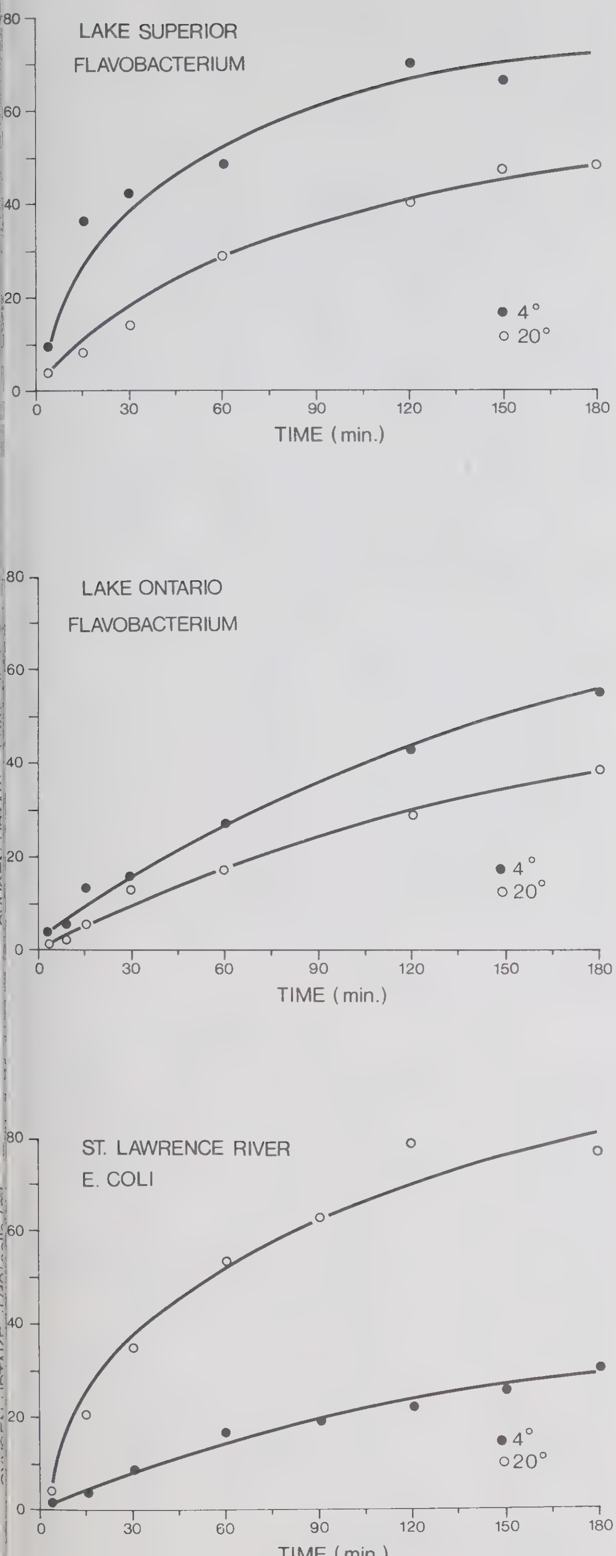


Figure 27. Effect of temperature on the oxygen utilization.

isolated from water-bodies such as the Great Lakes. Extension of these ideas and techniques indicates that such an approach will not only enable classification of organisms to be carried out but may also enable population structure to be accurately analysed. Changes in trophicstate of water-bodies will result in changes in the population structure of indigenous organisms; determination of changes in bacterial populations (most probably at the sub-specific level) should provide an early indication of changes in the trophic state.

Over 2,000 bacterial isolates were collected from both Lake Erie and Lake Superior between May and December 1973 (these two lakes being considered the most and least eutrophic respectively in the Great Lakes chain) and these isolates have each been subjected to over 150 characterization tests. The development of a range of tests applicable to the fresh-water isolates, and a semi-micro multipoint inoculation system has enabled the large volume of work involved to be accommodated routinely. Together with this, a series of computer programmes are being developed which will not only group the isolates but will also identify them.

Results of this study will not only provide information concerning the bacterial flora of the two lakes under investigation, but will indicate any cyclical population changes occurring as a result of such factors as temperature variation throughout the year. In addition, any differences in populations under the differing trophic conditions of Lake Erie and Lake Superior will become apparent. Investigations of these same lakes in subsequent years will indicate changes occurring over longer periods of time and may be correlated with other indications of change in trophic state. The study will be extended in subsequent years to include other lakes in the Great Lakes chain.

Closely allied to this study is the development of techniques to preserve isolates in such a way that their viability is retained with as little change as possible in their inherent characteristics. Methods of freeze-drying under investigation appear ideally suited for preservation of fresh-water isolates. Once such techniques have been adequately investigated, it is hoped to provide freeze-drying facilities for other workers and to develop and maintain a culture collection of fresh-water bacteria.

Virology

The virology programme initiated this year was based on contracted studies with three Canadian Universities and monitored by a consultant virologist, Dr. M.S. Mahdy. The following studies were integrated in three different contracts undertaken by the University of Western Ontario, the University of Guelph, and the University of Ottawa. While many of these studies are long-term, some of them such as (a) and (b) have been completed and others such as (c) and (e) have had certain phases completed.

(a) To measure the attachment of known doses and types of viruses to collection vessels. To develop methods to eliminate such attachment if it occurs.
(b) To determine the effect of transportation and handling processes on the viability of viral infec-

tivity prior to samples being received by the examining authority.

(c) To measure and compare the quantitative efficiency and the practicability of selected techniques for the concentration of small amounts of virus in large volumes of water. Experimentally seeded samples of tap, river and lake water were used for this purpose.

(d) To measure and control the quality of the methods selected for use. This was done by including in the samples collected and supplied by the Centre, coded specimens experimentally seeded with known doses and types of viruses.

(e) To establish and employ complementary techniques that enhance the sensitivity of detection of viruses in concentrated water samples. Such techniques include immunoabsorption, immunoelectron microscopy, and radio-immunoassay employing polyvalent antisera.

(f) To isolate, quantify and identify viruses in samples collected from: Ottawa River, Lake Ontario between the Toronto Harbour and Niagara Falls, influent and effluent of sewage treatment plants and from sites below, within, and above the plants. Preliminary information is thus obtained about the contamination of the above bodies of water. Data will also indicate the efficiency of sewage treatment processes in virus removal, and the contribution of treatment plants to viral pollution of water. The effect of dilution factors on pollution will also be recognized.

(g) To detect, quantify and group-identify animal viruses in farm effluent and to obtain data on the survival of animal viruses.

A very successful Symposium on "Viruses in th Environment and their Potential Hazards" was held a CCIW on November 14, 1973. From the presentations an following floor and panel discussions, conclusions reache were:

- Viruses are present in the environment at leve infective to man with the major risk being c low-level environmental transmission of viral infe tions that may be subsequently spread throug person-to-person contact.
- That present indicators of fecal contamination a not adequate indicators of viral pollution and thus is possible that water supplies apparently free c fecal contamination, may in fact be contaminate with viruses.
- The incidence of fish tumours apparently increas in chemically polluted waters. These waters are al polluted with human viruses, thus carcinogenes may be effected through a combined effect of the agents. CCIW is sponsoring further research in 197 on this matter at the University of Guelph.

Physical Sciences Laboratories Section

This Section has two operating laboratories, Radi chemistry and Electron Microscopy. The Radiochemist Laboratory is concerned with the behaviour of radi nuclides entering the Great Lakes system from the rapid growing nuclear power industry and other sources, and th use of nuclear methods to aid scientific research at CCIV The Electron Microscopy Laboratory is developing tec niques for observing and analysing microscopic objects of

Table 2. 1973 Radionuclide Survey of Great Lakes Waters

Lake	Sample Station: N. Lat.	Sample Station: W. Long.	Date	Level in pCi/litre: ^{137}Cs	Level in pCi/litre: ^{125}Sb
Superior	47° 12′ 24″	89° 40′ 00″	20/5/73	0.063 ± .006	0.046 ± .015
	47° 50′ 51″	87° 27′ 36″	18/5/73	0.087 ± .006	0.041 ± .011
	47° 12′ 30″	85° 37′ 36″	13/5/73	0.077 ± .007	0.045 ± .013
Huron	45° 42′ 15″	83° 16′ 09″	10/5/73	0.041 ± .005	0.046 ± .014
	45° 01′ 06″	82° 37′ 42″	10/5/73	0.042 ± .005	0.101 ± .017
	43° 38′ 00″	82° 13′ 12″	10/5/73	0.035 ± .004	0.087 ± .011
Erie	41° 52′ 36″	82° 52′ 53″	29/5/73	0.035 ± .007	0.096 ± .016
	42° 10′ 30″	81° 03′ 12″	30/5/73	0.023 ± .007	0.089 ± .017
	42° 34′ 18″	79° 45′ 12″	30/5/73	0.015 ± .005	0.093 ± .017
Ontario	43° 25′ 00″	79° 16′ 30″	5/6/73	0.032 ± .006	0.083 ± .016
	43° 39′ 44″	77° 43′ 25″	5/6/73	0.042 ± .006	0.083 ± .013
	43° 43′ 51″	76° 30′ 13″	6/6/73	0.070 ± .007	0.142 ± .017
	43° 18′ 10″	79° 47′ 18″	24/5/73	0.057 ± .007	0.078 ± .016
Pickering	43° 48′ 25″	79° 02′ 08″	29/5/73	0.027 ± .006	0.103 ± .018
	43° 48′ 05″	79° 03′ 25″	29/5/73	0.035 ± .006	0.090 ± .020
	43° 48′ 03″	79° 05′ 05″	29/5/73	0.025 ± .006	0.070 ± .017
Douglas Point	44° 19′ 13″	81° 36′ 36″	11/6/73	0.019 ± .006	0.082 ± .016
	44° 19′ 51″	81° 36′ 26″	11/6/73	0.018 ± .005	0.076 ± .017
	44° 20′ 26″	81° 35′ 34″	11/6/73	0.014 ± .010	0.124 ± .038

eological, biological and microbiological nature to aid ;CIW scientists in limnological and environmental impact tudies.

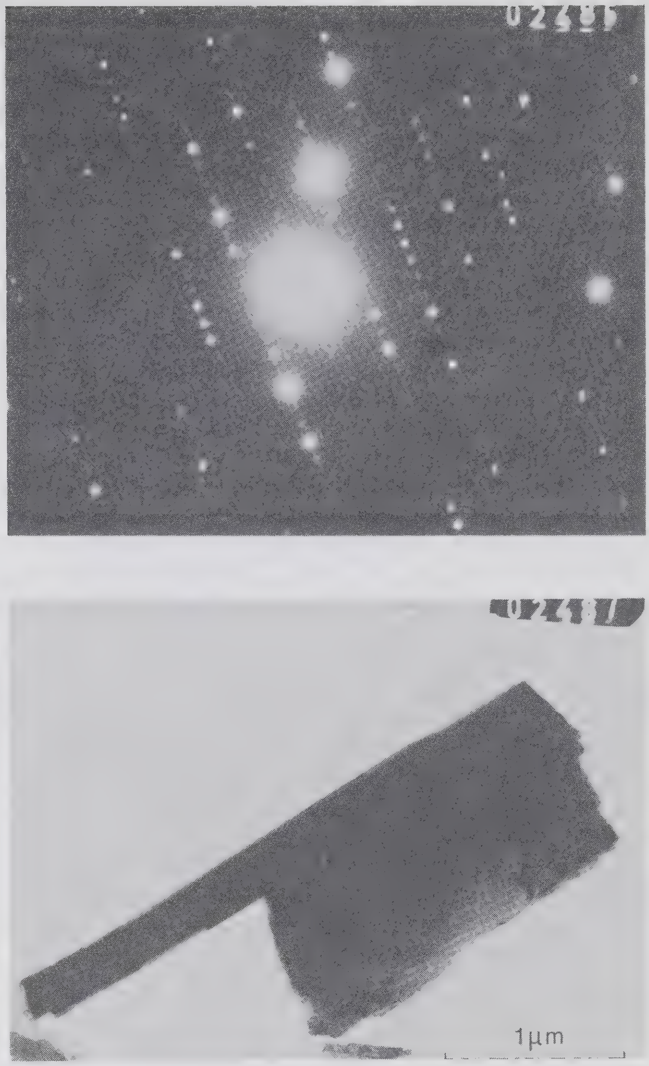
?adiochemistry Laboratory

A survey of the levels of artificial radionuclides in ìreat Lakes waters, sediments and biota got underway in 973 with measurements of γ-emitting radionuclides in vater samples from Lakes Superior, Huron, Erie and)ntario. Samples were also taken offshore from the two)ntario nuclear generating stations at Douglas Point on .ake Huron and Pickering on Lake Ontario to measure any adioactive input to the lakes from these sources. Only two '-emitting radionuclides that do not occur naturally were ound, ^{137}Cs and ^{125}Sb, but at extremely low concentraions as shown in Table 2. No input was detectable from he nuclear generating stations so the levels are due to allout from nuclear weapons testing. Consequently, there iow exists a set of baseline values to measure the future mpact of the nuclear power industry.

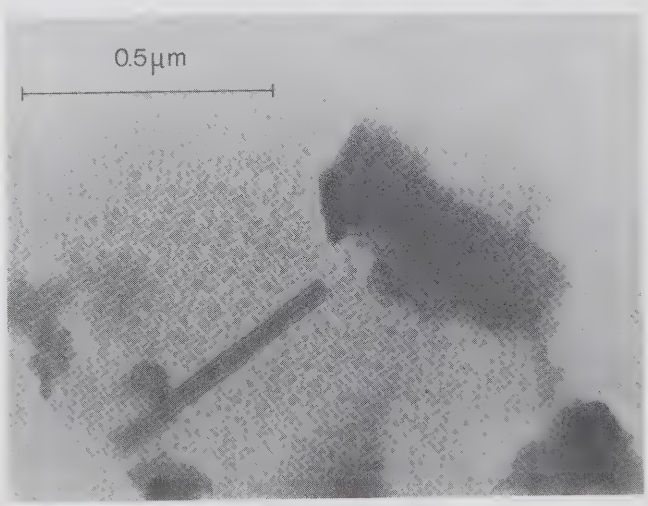
The movement of sediment in a near-shore zone of .ake Ontario was followed using an insert of neutron ictivable glass sand in conjunction with Geolimnology ìection, LRD. The glass sand which was ground and sieved iy Ontario Research Foundation, contained about 4% by veight of antimony. Core samples were periodically taken in a grid pattern around the point of insertion and inalyzed for antimony by neutron activation. Dried secions of the cores weighing about 100 mg were irradiated or 10 minutes at 1×10^{13} n cm^{-2} s^{-1} and the ^{122}SB γ-ray it 560 Kev measured after allowing most of the ^{24} Na to lecay. The detection limit was about 0.5 ppm antimony vhile the concentration of antimony in the sediment was ess than 0.2 ppm, so that no background interference iccurred.

:lectron Microscope Laboratory

A study of the distribution of asbestos fibres in Lake ìuperior was started during 1973 to determine whether lumping of asbestos containing mining and milling tailings rom operations in Minnesota was affecting Canadian vaters. Initially, the tailings were studied in cooperation vith Geolimnology Section, LRD, to determine what ipecific asbestiform minerals could be expected in the lake vater. Samples of different particle size fractions obtained rom Geolimnology Section's size distribution analysis of he tailings, were scrutinized in the scanning electron nicroscope. It was found that the asbestiform minerals vere concentrated in the finer particles and accounted for he bulk of the material in the less than 2 μm fraction. A ample of this fraction was mounted in the transmission lectron microscope and electron diffraction patterns taken of individual fibres. Those obtained were all identical with hat of cummingtonite from a standard sample of this nineral. Preliminary results of analyses of water samples rom a station in Thunder Bay and another, 5 miles off ìilver Bay, Minnesota were: Thunder Bay — 1×10^6 fibres per litre and Silver Bay — 9×10^6. The Thunder Bay fibres vere distributed normally with a mean length of 0.2 μm vhile those from Silver Bay ranged from 0.1 to 4 μm long.



Micrograph and electrondiffraction pattern of fibre in water off Silver Bay.



Chrysotile fibres in water sample from near Isle Royale.

The Thunder Bay fibres had the characteristic "hollow-tube" appearance of chrysotile but those from off Silver Bay, where the tailings are dumped, were identified by electron diffraction, as cummingtonite. It would appear from these early results that no significant transboundary movement of the tailings occurs.

In cooperation with Biolimnology Laboratories of F.R.D., an investigation of the effects of PCB on the internal structure of the green algae, Ankistrodemus Falcatus, was carried out by electron microscopy. Two batches of green algae were inoculated with 50 and 10 ppb of PCB and incubated for 2 days. A third batch of algae was used as a control. After fixation and embedding in Epon, thin sections were examined under the transmission electron microscope. Compared to the control, the PCB treated algae indicated a marked change in the internal structure. There was a disruption of the chloroplasts and an increase in the number of vacuoles which explained the decrease in the photosynthetic activity of the algae after treatment with PCB at the ppb level. The results were presented by Dr. Val Glooschenko at the 1973 Conference on the International Association of Great Lakes Research.

In cooperation with Dr. P. Wong, of Great Lakes Biolimnology Laboratories, a technique was developed to observe the localization of the alkaline phosphatase in E. Coli. Bacteria grown in high and in low-phosphate media were processed and stained with lead nitrate and thin sections observed with the transmission electron microscope. Those with high concentrations of phosphatase enzymes, which were induced by the low phosphate growth medium, were heavily stained by black lead deposits, whereas bacteria without any phosphatase, which grew in the high phosphate medium, were not stained.

Technical Operations Section

The Technical Operations Section has the responsibility for the multi-disciplinary field measurements carried out from major and minor vessels in support of scientific projects conducted at CCIW, the Pacific and Western Regions. The Section provides on request, the expertise required to support all scientific field research undertaken by conponents of CCIW from several services and departments.

Major Ships

The C.S.S. LIMNOS and the chartered vessel, M.V. MARTIN KARLSEN continued to carry out the bulk of the Great Lakes work this year. Up to March 31, these surveys were augmented, from time to time, with work done by the C.C.G.S. PORTE DAUPHINE, through contract arrangements with the Great Lakes Institute, University of Toronto. On completion of the IFYGL program on Lake Ontario in March, the emphasis shifted, under the IJC Upper Lakes Reference, to work in the Upper Lakes, particularly Lake Superior.

The C.S.S. LIMNOS carried out a large variety of cruises including monitor, mooring, sediment survey and coring cruises and several special surveys (nutrient recycling in the water column; distribution of sulphur isotopes in the sediments) making a total of 31 for the 1973 season. The can be broken down as follows:

9 Heat Content Surveys (IFYGL)	Lake Ontario
3 U.S. Biochemical Surveys (IFYGL)	Lake Ontario
4 Mooring Cruises (IFYGL)	Lake Ontario
1 Engineering/Water Quality Trials	Lake Ontario
4 Monitor Cruises (1 special)	Lake Erie
2 Water Column Studies	Lake Erie
1 Coring Cruise (Upper Lakes IJC Ref)	Georgian Bay
1 Mooring Cruise (Upper Lakes IJC Ref)	Lake Huron
3 Mooring Cruises (Upper Lakes IJC Ref)	Lake Superior
3 Sediment Surveys (Upper Lakes IJC Ref)	Lake Superior, Georgian Bay, an North Channel, Lake Huron

The monitor cruises in Lake Erie were the first for t LIMNOS since 1968. The regional sediment surveys in La Superior, Georgian Bay and the North Channel of La Huron, part of the IJC Upper Lakes Reference, complet the overall survey of the Great Lakes (with the exception Lake Michigan, which is entirely within U.S. jurisdictio The coring cruise, also in Georgian Bay, was conducted define more carefully, the sub-bottom strata observed the echograms and to delineate the low-level boundaries Georgian Bay. Very few problems were encountered duri the year and those that did arise were quickly rectified ships' personnel and/or Engineering Systems staff.

To meet the requirement of the increased emphasis the Upper Lakes, six monitor cruises were successfu completed by the M.V. MARTIN KARLSEN in La Superior. In addition, the following cruises were a completed on the Great Lakes to make a total of 21 for KARLSEN in 1973:

1 Heat Content Survey (IFYGL)	Lake Ontario
2 OOPS Cruises (IFYGL)	Lake Ontario
1 Buoy Retrieval (IFYGL)	Lake Ontario
2 Geology Cruises	Lake Ontario
4 Monitor Cruises	Lake Ontario
2 Geology Cruises	Lake Superior
1 Monitor Cruise	Lake Erie
2 Monitor Cruises	Lake Huron

The total miles steamed for both ships in 1973 w 28% more than last year (Table 3).

Completed schedules for the major ships are giver separate tables.

During the greater part of 1973, the C.C.G.S. POR DAUPHINE was based at CCIW and funded by MSD. T arrangement with the Ministry of Transport permitted vessel to complete about 13 cruises, most of which w

affed and co-ordinated by Technical Operations personel. The cruises included Heat Content Surveys of Lake ntario (as part of IFYGL) and current meter moorings in ake Ontario and the St. Lawrence River. During the onths of June, July and August, the DAUPHINE, staffed y MSD personnel carried out hydrographic work in the wer St. Lawrence River.

The C.S.S. ADVENT, the new addition to the CCIW fleet" spent the first month of the field season undergoing ials and renovations to make it more suitable for mnological work on the lakes. For the remainder of the ear, the vessel participated in a variety of cruises on Lakes ntario, Erie, St. Clair and Superior including hydrographic rveys, equipment trials, coring, N.T.A. monitoring, virolgy, mycology and support of the Point Source Effluent udy at Marathon on Lake Superior.

Until the expiry of her charter in August 1973, the .V. LAC ERIE was actively involved in regional sediment rveys and geophysical studies on the Great Lakes. In ddition, she completed a number of other tasks including unching and recovering moorings, servicing the meteorogical buoy network, N.T.A. monitoring, and engineering eld trials.

The C.S.L. SHARK, in addition to supporting several her programs during 1973, provided support for all diving perations in Lakes Ontario, Erie, and St. Clair.

nall Craft

The Technical Operations Section continued to particate in the Vessel Assignments Committee to co-ordinate, rough the Central Region, Marine Sciences Directorate, e assignment of small craft to the various scientific ctions at CCIW, universities and other outside agencies.

rsonnel

Personnel from the Section were assigned to major and inor ships throughout the season, and to small craft volved with "shore-based" operations at the Bay of uinte, Burlington, Marathon and the Lower St. Lawrence.

The staff were responsible for all deck observations, eteorological observations, field equipment and co-ordinaon of vessel movement.

A short in-house course in basic electricity and ectronics (designed to broaden the capabilities of Techcal Operations personnel in areas which would be of actical value in future field projects), was run in ebruary.

Seven students were employed during the summer onths of field operations. Nine term employees have also en hired bringing the total number in the Section to 37.

Program Support

Technical Operations Section continued their support of numerous "shore-based" operations during 1973.

a. Meteorological Measurement Programs
b. Lake Ontario Shore Sensor Program
c. N.T.A. Monitoring
d. Point Source Study at Marathon
e. Wave Climatology and Beach Stability
f. M.S.D. Wave River Program
g. Bay of Quinte (nutrient dynamics)
h. Water Quality Studies on the St. Lawrence and St. Mary's River (WQB)
i. Oil Spill Cleanup and Remote Sensing
j. Deep Water Port Feasibility Study at Kamouraska, Que. (MSD)

Diving Unit

During 1973, the diving unit actively supported 18 scientific programs in the Great Lakes and St. Lawrence River, with tasks ranging from cable laying and inspection to selective hand coring for chemical analyses. In 207 diving days, the unit logged 924 diving hours. Extensive use was made of the new diving system consisting of surface supplied air, unisuits, Kirby-Morgan masks and the underwater T.V. system with video tape and communications.

The diving tender C.S.L. SHARK, supported all diving in Lakes Ontario, Erie and St. Clair.

Riggers/Stores

The rigging unit continued to equip and support all field parties with which staff from the Section were associated. Instrument towers, trailers and modifications to various types of buoys were among the high priority commitments along with normal maintenance of winches and generators.

Reports

Technical Operations has assumed the responsibility of preparing preliminary descriptive limnology reports upon the completion of each monitor cruise. Although they provide only a very cursory look at lake conditions the up-to-date nature of these reports will lead to improve quality control of the data collected.

Other Activities

Personnel also participated in air/sea rescue operations in co-operation with the Coast Guard and managed to save the life of a helicopter pilot downed in Lake Superior in June.

Table 3. Schedules for C.S.S. LIMNOS and M. V. MARTIN KARLSEN

iip	Started Operations	Completed Operations	No. of Cruises	Miles Steamed	Days at CCIW (%)	Active Days (%)
.S.S. LIMNOS	Jan. 8	Dec. 10	31	22,386	32	68
.V. MARTIN KARLSEN	Jan. 3	Dec. 7	21	23,818	40	60

Table 4. Great Lakes Studies, 1973. C.S.S. LIMNOS

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN		1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 Depart CCIW 1212 hrs.	9 Lake Ontario	10 Heat Content	11 Survey	12 Arrive CCIW 0840 hrs.	13 CCIW
	14 CCIW	15 Depart CCIW 1124 hrs.	16 Lake Ontario	17 Heat Content Survey	18 Arrive CCIW 2225 hrs.	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 Depart CCIW 1103 hrs.	30 Lake Ontario Heat Content Survey	31 Arrive Toronto 2345 hrs.	1 In Transit	2 CCIW	3 CCIW
FEB	4 CCIW	5 Depart CCIW 1030 hrs.	6 Lake Ontario	7 U.S. Biochemical	8 Survey	9 Arrive CCIW 0800 hrs.	10 CCIW
	11 CCIW	12 Depart CCIW 1003 hrs.	13 Lake Ontario	14 Heat Content Survey	15 Arrive CCIW 1625 hrs.	16 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 CCIW	24 CCIW
	25 CCIW	26 Depart CCIW 0955 hrs.	27 Lake Ontario	28 Heat Content Survey	1 Arrive CCIW 0930 hrs.	2 CCIW	3 CCIW
MAR	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
	11 CCIW	12 Depart CCIW 1057 hrs.	13 Lake Ontario Heat Content Survey	14 Arrive CCIW 2045 hrs.	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 Depart CCIW 1052 hrs.	20 Lake Ontario	21 U.S. Biochemical	22 Survey	23 Arrive CCIW 0905 hrs.	24 CCIW
	25 CCIW	26 Depart CCIW 0955 hrs.	27 Lake Ontario Heat Content Survey	28 End of Cruise 1150 hrs.	29 Lake Ontario	30 Moorings	31 Arrive CCIW 1305 hrs.
APR	1 CCIW	2 Depart CCIW	3 Lake Ontario	4 Moorings	5 Arrive CCIW	6 CCIW	7 CCIW
	8 CCIW	9 Depart CCIW 1000 hrs.	10 Lake Erie	11 Monitor	12 Lake Erie	13 Monitor	14 Lake Erie
	15 Monitor	16 Lake Erie	17 Arrive CCIW 2330 hrs.	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 1055 hrs.	25 Lake Superior	26 Regional	27 Sediment	28 Survey
MAY	29 Lake Superior	30 Regional	1 Sediment	2 Survey	3 Lake Superior	4 Regional	5 Sediment
	6 Survey	7 Lake Superior	8 Arrive Thunder Bay 0845 hrs.	9 Depart Thunder Bay 0700 hrs.	10 Lake Superior	11 Regional	12 Sediment
	13 Survey	14 Lake Superior	15 Regional	16 Sediment	17 Survey	18 Arrive Sault Ste. Marie 1023 hrs.	19 Depart Sault Ste. Marie 1855 hrs.
	20 Lake Superior	21 Moorings	22 Lake Superior	23 Moorings	24 Lake Superior	25 Moorings	26 Lake Superior
	27 Moorings	28 Lake Huron	29 Moorings	30 Arrive CCIW 0000 hrs.	31 CCIW	1 CCIW	2 CCIW
JUNE	3 CCIW	4 Depart CCIW 1055 hrs.	5 Lake Ontario	6 Heat Content Survey	7 Arrive CCIW 1620 hrs.	8 CCIW	9 CCIW
	10 CCIW	11 Depart CCIW 1110 hrs.	12 Lake Ontario	13 U.S. Biochemical	14 Survey	15 Arrive CCIW 0230 hrs.	16 CCIW
	17 In Transit	18 Depart Port Stanley 1212 hrs.	19 Lake Erie	20 Water Column	21 Study	22 Arrive Port Colborne 0558 hrs.	23 In Transit
	24 CCIW	25 Depart CCIW 1329 hrs.	26 Lake Ontario	27 Heat Content Survey	28 Moorings	29 Arrive CCIW 0945 hrs.	30 CCIW
JULY	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW
	8 CCIW	9 ----------	10 ----------	11 DRY DOCK	12 ----------	13 ----------	14 ----------
	15 ----------	16 ----------	17 ----------	18 DRY DOCK	19 ----------	20 ----------	21 ----------
	22 CCIW	23 CCIW	24 Depart CCIW 0910 hrs.	25 Lake Erie	26 Monitor	27 Lake Erie	28 Monitor
	29 Lake Erie	30 Arrive Port Stanley 1235 hrs.	31 Port Stanley	1 Depart Port Stanley 1420 hrs.	2 Lake Erie	3 Water Column Study	4 Arrive Port Stanley 1830 hrs.
AUG	5 Port Stanley	6 In Transit	7 Depart Sarnia 2040 hrs.	8 Lake Superior	9 Moorings	10 Lake Superior	11 Moorings
	12 Lake Superior	13 Moorings	14 Lake Superior	15 Moorings	16 Lake Superior	17 Moorings	18 Lake Superior
	19 Moorings	20 Lake Superior	21 Moorings	22 Arrive Sarnia 2320 hrs.	23 Sarnia	24 Sarnia	25 Sarnia
	26 Sarnia	27 Depart Sarnia 1405 hrs.	28 Lake Erie	29 Special Monitor	30 Arrive Port Colborne 0025 hrs.	31 In Transit	1 Port Stanley
SEPT	2 Port Stanley	3 Port Stanley	4 Depart Port Stanley 1500 hrs.	5 Lake Erie	6 Water Column Study	7 Arrive Port Stanley 0626 hrs.	8 In Transit
	9 In Transit	10 Depart Owen Sound 1335 hrs.	11 Regional	12 Sediment Survey	13 Georgian Bay	14 Arrive Owen Sound 1107 hrs.	15 Owen Sound
	16 Owen Sound	17 Depart Owen Sound 0025 hrs.	18 Regional	19 Sediment Survey	20 Georgian Bay	21 Arrive Owen Sound 1222 hrs.	22 Owen Sound
	23 Owen Sound	24 Depart Owen Sound 1110 hrs.	25 Sediment Survey	26 Arrive Owen Sound 1520 hrs.	27 Owen Sound	28 Owen Sound	29 Depart Owen Sound 2353 hrs.
OCT	30 Lake Superior	1 Moorings	2 Lake Superior	3 Moorings	4 Lake Superior	5 Moorings	6 Lake Superior
	7 Moorings	8 Arrive CCIW 1010 hrs.	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 Depart CCIW 0805 hrs.	19 Lake Ontario Moorings, Arr.CCIW	20 CCIW
	21 CCIW	22 Depart CCIW 1055 hrs.	23 Georgian Bay	24 Coring	25 Georgian Bay	26 Coring	27 Georgian Bay
	28 Coring	29 Georgian Bay	30 Coring	31 Georgian Bay	1 Arrive CCIW 0350 hrs.	2 CCIW	3 CCIW
NOV	4 CCIW	5 Depart CCIW 1010 hrs.	6 Lake Erie	7 Monitor	8 Lake Erie	9 Monitor	10 Lake Erie
	11 Monitor	12 Lake Erie	13 Monitor	14 Arrive Sarnia 0328 hrs.	15 Depart Sarnia	16 Lake Huron	17 Moorings
	18 Lake Huron	19 Moorings	20	21 Arrive CCIW 1610 hrs.	22 Depart CCIW 1123 hrs.	23 Eng.Trials,Arr. CCIW 1345 hrs.	24 CCIW
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	1 CCIW
DEC	2 CCIW	3 CCIW	4 Depart CCIW 0800 hrs.	5 Lake Ontario	6 Moorings	7 Lake Ontario	8 Moorings
	9 Lake Ontario	10 Arrive CCIW 1325 hrs.	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW
	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW
	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW

Table 5. Great Lakes Studies, 1973. M.V. MARTIN KARLSEN

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1 CCIW	2 CCIW	3 Depart CCIW 1125 hrs.	4 Lake Ontario	5 Heat Content Survey	6 Arrive CCIW 1345 hrs.
	7 CCIW	8 CCIW	9 Depart CCIW 1010 hrs.	10 Lake Ontario	11 Organic Particle Study	12 Arrive CCIW 0820 hrs.	13 CCIW
JAN	14 CCIW	15 Depart CCIW 1145 hrs.	16 Organic Particle Study	17 Lake Ontario	18 Organic Particle Study	19 Phase II	20 Arrive CCIW 0905 hrs.
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1 CCIW	2 CCIW	3 CCIW
	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
FEB	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 CCIW	24 CCIW
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	1 CCIW	2 CCIW	3 CCIW
	4 CCIW	5 Depart CCIW 1540 hrs.	6 Lake Ontario	7 Organic Particle	8 Study	9 Arrive CCIW 0815 hrs.	10 CCIW
MAR	11 CCIW	12 Depart CCIW 1110 hrs.	13 Lake Ontario	14 Organic Particle	15 Study	16 Phase II	17 Arrive CCIW 0830 hrs.
	18 CCIW	19 Depart CCIW 1145 hrs.	20 Lake Ontario	21 Monitor	22 Lake Ontario	23 Monitor	24 Arrive CCIW 1600 hrs.
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW
	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW
	8 CCIW	9 Depart CCIW 1025 hrs.	10 Coring	11 Lake Ontario	12 Arrive CCIW 1755 hrs.	13 CCIW	14 CCIW
APR	15 CCIW	16 Depart CCIW 1105 hrs.	17 Lake Ontario Terrestial Heat	18 Arrive CCIW 1910 hrs.	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 1125 hrs.	25 Lake Ontario	26 Monitor	27 U.S. Biochemical	28 Survey
	29 Arrive CCIW 0855 hrs.	30 CCIW	1 Depart CCIW 0915 hrs.	2 Lake Ontario Radon & Moorings	3 Arrive CCIW 1522 hrs.	4 CCIW	5 CCIW
	6 CCIW	7 Depart CCIW 1030 hrs.	8 Lake Huron	9 Monitor	10 Lake Huron	11 Monitor	12 Sault Ste. Marie
MAY	13 Lake Superior	14 Monitor	15 Lake Superior	16 Monitor	17 Lake Superior	18 Monitor	19 Thunder Bay
	20 Lake Superior	21 Monitor	22 Lake Superior	23 Monitor	24 Arrive Sault Ste. Marie 0845 hr.	25 Sault Ste. Marie	26 Sault Ste. Marie
	27 Sault Ste. Marie	28 Sault Ste. Marie	29 Depart Sault Ste. Marie 1437 hrs	30 Lake Superior	31 Coring	1 Geophysical	2 and
	3 Geochemical	4 Lake Superior	5 Lake Superior	6 Coring	7 Geophysical	8 and	9 Geochemical
JUNE	10 Lake Superior	11 Arrive Sault Ste. Marie 1300 hrs.	12 Sault Ste. Marie	13 Sault Ste. Marie	14 Sault Ste. Marie	15 Depart Sault Ste. Marie 1200 hrs.	16 Lake Superior
	17 Monitor	18 Lake Superior	19 Monitor	20 Lake Superior	21 Monitor	22 Lake Superior	23 Monitor
	24 Lake Superior	25 Monitor	26 Lake Superior	27 Monitor	28 Arrive Sault Ste Marie 1440 hrs.	29 In Transit	30 In Transit
	1 In Transit	2 ----------	3 ------------	4 DOWN	5 TIME	6 ---------	7 ---------
	8 ----------	9 ---------	10 -----------	11 DOWN	12 TIME	13 --------	14 --------
JULY	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 In Transit	24 In Transit	25 In Transit	26 Depart Sault Ste Marie 2018 hrs.	27 Lake Superior	28 Monitor
	29 Lake Superior	30 Monitor	31 Lake Superior	1 Monitor	2 Lake Superior	3 Monitor	4 Lake Superior
	5 Monitor	6 Lake Superior	7 Monitor	8 Arrive Sault Ste. Marie 1155 hrs.	9 Sault Ste. Marie	10 Sault Ste. Marie	11 Sault Ste. Marie
AUG	12 Sault Ste. Marie	13 Depart Sault Ste. Marie 1645 hrs.	14 Lake Superior	15 Coring	16 Lake Superior	17 Coring	18 Lake Superior
	19 Coring	20 Lake Superior	21 Coring	22 Lake Superior	23 Arrive Sault Ste. Marie 0500 hrs.	24 In Transit	25 In Transit
	26 Depart Sarnia 0930 hrs.	27 Lake Erie	28 Monitor	29 Lake Erie	30 Monitor	31 Lake Erie	1 Arrive Sault Ste. Marie 0615 hrs.
	2 Sarnia	3 Sarnia	4 Depart Sarnia 1555 hrs.	5 Lake Superior	6 Monitor	7 Lake Superior	8 Monitor
SEPT	9 Lake Superior	10 Monitor	11 Lake Superior	12 Monitor	13 Lake Superior	14 Monitor	15 Lake Superior
	16 Monitor	17 Lake Superior	18 Sault Ste. Marie	19 Lake Huron	20 Monitor	21 Arrive Sarnia 0145 hrs.	22 In Transit
	23 In Transit	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW
	30 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 CCIW	9 Depart CCIW 1746 hrs.	10 In Transit	11 In Transit	12 In Transit	13 Lake Superior
OCT	14 Monitor	15 Lake Superior	16 Monitor	17 Lake Superior	18 Monitor	19 Lake Superior	20 Monitor
	21 Lake Superior	22 Monitor	23 Lake Superior	24 Monitor	25 Lake Superior	26 In Transit	27 In Transit
	28 In Transit	29 Arrive CCIW 1140 hrs.	30 Depart CCIW 1120 hrs.	31 Lake Ontario	1 Monitor	2 Lake Ontario	3 Monitor
	4 Arrive CCIW 0350 hrs.	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
NOV	11 CCIW	12 CCIW	13 Depart CCIW 1108 hrs.	14 In Transit	15 In Transit	16 In Transit	17 In Transit
	18 Lake Superior	19 Monitor	20 Lake Superior	21 Monitor	22 Lake Superior	23 Monitor	24 Lake Superior
	25 Monitor	26 Lake Superior	27 Monitor	28 Lake Superior	29 Monitor	30 In Transit	1 In Transit
	2 In Transit	3 Arrive CCIW 2145 hrs.	4 Depart CCIW 1250 hrs.	5 Lake Ontario	6 Monitor	7 Arrive CCIW 0135 hrs.	8 CCIW
DEC	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW
	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW
	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW

Table 6. Great Lakes Studies, 1973. C.C.G.S. PORTE DAUPHINE

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN		1	2 Depart Toronto 2140 hrs.	3 Lake Ontario	4 Heat Content Survey	5 Arrive Toronto 0900 hrs.	6 Toronto
	7 Toronto	8 Toronto	9 Depart Toronto 0950 hrs.	10 Heat Content Survey & Coring	11 Arrive Toronto 0007 hrs.	12 Toronto	13 Toronto
	14 Toronto	15 Depart Toronto 1140 hrs.	16 Lake Ontario	17 Heat Content Survey	18 Arrive Toronto 1104 hrs.	19 Toronto	20 Toronto
	21 --------	22 --------	23 --------	24 Toronto	25 --------	26 --------	27 --------
FEB	28 Toronto	29 Depart Toronto 1150 hrs.	30 Lake Ontario	31 Heat Content Survey	1 Arrive Toronto 0438 hrs.	2 Toronto	3 Toronto
	4 --------	5 --------	6 --------	7 Toronto	8 --------	9 --------	10 --------
	11 --------	12 --------	13 --------	14 Toronto	15 --------	16 --------	17 --------
	18 --------	19 --------	20 --------	21 Toronto	22 --------	23 --------	24 --------
	25 --------	26 --------	27 --------	28 Toronto	1 --------	2 --------	3 --------
MAR	4 --------	5 --------	6 --------	7 Toronto	8 --------	9 --------	10 --------
	11 Toronto	12 Depart Toronto 1552 hrs.	13 Heat Content Survey	14 Arrive Toronto 2017 hrs.	15 Toronto	16 Toronto	17 Toronto
	18 --------	19 --------	20 --------	21 Toronto	22 --------	23 --------	24 --------
	25 Toronto	26 Depart Toronto 0955 hrs.	27 Heat Content Survey	28 Arrive Toronto 1405 hrs.	29 Toronto	30 Toronto	31 Toronto
APR	1 Toronto	2 Depart Toronto 1105 hrs.	3 Lake Ontario	4 Heat Content	5 Survey	6 Arrive Toronto 0224 hrs.	7 Toronto
	8 --------	9 --------	10 --------	11 Toronto	12 --------	13 --------	14 --------
	15 --------	16 --------	17 --------	18 Toronto	19 --------	20 --------	21 --------
	22 --------	23 --------	24 --------	25 Toronto	26 --------	27 --------	28 --------
MAY	29 Toronto	30 Depart CCIW 1030 hrs.	1 Lake Ontario	2 Heat Content Survey	3 Arrive CCIW 0530 hrs.	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW
	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 Depart CCIW	18 In Transit	19 Arrive Quebec
	20 Quebec	21 Depart Quebec	22 Quebec	23 Anchorage Site	24 Arrive Quebec	25 Quebec	26 Quebec
	27 Quebec	28 Arrive Anchorage	29 St. Lawrence	30 St. Lawrence	31 St. Lawrence	1 St. Lawrence	2 Point au Pic
JUNE	3 Point au Pic	4 St. Lawrence	5 St. Lawrence	6 St. Lawrence	7 St. Lawrence	8 St. Lawrence	9 Point au Pic
	10 Point au Pic	11 St. Lawrence	12 St. Lawrence	13 St. Lawrence	14 St. Lawrence	15 St. Lawrence	16 Point au Pic
	17 Point au Pic	18 St. Lawrence	19 St. Lawrence	20 St. Lawrence	21 St. Lawrence	22 St. Lawrence	23 St. Lawrence
	24 Depart Anchorage Area	25 Quebec	26 In Transit	27 In Transit	28 In Transit	29 Arrive CCIW	30 CCIW
JULY	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW
	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 Leave CCIW 1000 hrs.	18 In Transit	19 In Transit	20 In Transit	21 In Transit
	22 Arrive Quebec	23 Depart Quebec 1200 hrs.	24 Mooring Survey off St. Francois	25 Mooring	26 Mooring	27 Arrive Quebec 1430 hrs.	28 Quebec
AUG	29 Quebec	30 Survey Site Tower Location	31 Tower Site	1 Tower Site	2 Tower Site	3 Arrive Quebec 1400 hrs.	4 Quebec
	5 Quebec	6 Survey Site	7 Survey Site	8 Survey Site	9 Survey Site	10 Survey Site	11 Survey Site
	12 Survey Site	13 Survey Site	14 Survey Site	15 Survey Site	16 Survey Site	17 Arrive Quebec 1700 hrs.	18 Quebec
	19 Quebec	20 Survey Site	21 Survey Site	22 Survey Site	23 Survey Site	24 Arrive Quebec 1200 hrs.	25 Quebec
	26 Quebec	27 Depart Quebec 0800 hrs.	28 In Transit	29 In Transit	30 In Transit	31 In Transit	1 Arrive CCIW
SEPT	2 CCIW	3 Depart CCIW	4 Lake Ontario Hamilton-Scourge	5 Hamilton-Scourge	6 Hamilton-Scourge	7 Hamilton-Scourge	8 CCIW
	9 CCIW	10 Hamilton-Scourge	11 Hamilton-Scourge	12 --------	13 --------	14 --------	15 CCIW
	16 CCIW	17 --------	18 --------	19 Hamilton-Scourge	20 --------	21 --------	22 CCIW
	23 CCIW	24 --------	25 --------	26 Hamilton-Scourge	27 --------	28 --------	29 CCIW
OCT	30 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 CCIW	9 Depart CCIW 1100 hrs.	10 Lake Ontario Coring	11 Arrive CCIW 1600 hrs.	12 CCIW	13 CCIW
	14 CCIW	15 CCIW	16 Depart CCIW	17 Lake Ontario Hamilton-Scourge	18 Arrive CCIW	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 Depart CCIW 1550 hrs.	25 Remote Sensing ERTS	26 Remote Sensing ERTS	27 Remote Sensing ERTS
NOV	28 Arrive CCIW 1850 hrs.	29 Depart CCIW	30 Lake Ontario Hamilton-Scourge	31 Hamilton-Scourge	1 Hamilton-Scourge	2 Arrive CCIW	3 CCIW
	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW
	18 --------	19 --------	20 --------	21 CCIW	22 --------	23 --------	24 --------
	25 --------	26 --------	27 --------	28 CCIW	29 --------	30 --------	1 --------
DEC	2 --------	3 --------	4 --------	5 CCIW	6 --------	7 --------	8 --------
	9 CCIW	10 Depart CCIW 0800 hrs.	11 Monitor-NTA	12 Lake Ontario	13 Moorings Wolfe Island Area	14 Arrive CCIW 0300 hrs.	15 CCIW
	16 CCIW	17 Location of Buoys	18 Toronto Area	19 CCIW	20	21	22
	23	24	25	26	27	28	29

Table 7. Great Lakes Studies, 1973. C.S.S. ADVENT

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN		1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
FEB	28	29	30	31	1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
MAR	25	26	27	28	1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
APR	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
MAY	29	30	1	2	3	4	5
	6	7	8	9	10	11	12
	13 Outfitting	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW
	20 CCIW	21 CCIW	22 Depart CCIW 1225 hrs.	23 Lake	24 Ontario	25 Bathymetric	26 Survey
	27 Arrive CCIW 1915 hrs.	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1 CCIW	2 CCIW
JUNE	3 CCIW	4 CCIW	5 Equipment	6 Trials	7 CCIW	8 CCIW	9 CCIW
	10 CCIW	11 CCIW	12 Equipment	13 Trials	14 CCIW	15 Equipment Trials	16 CCIW
	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 CCIW
	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW
JULY	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 Equipment Trials	6 CCIW	7 CCIW
	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 Depart CCIW 0900 hrs.	18 In Transit	19 In Transit	20 In Transit	21 In Transit
	22 Arrive Sault Ste Marie 1545 hrs.	23 Downtime Sault Ste. Marie	24 Downtime Sault Ste. Marie	25 Downtime Sault Ste. Marie	26 Downtime Sault Ste. Marie	27 In Transit	28 Marathon
AUG	29 ----------	30 ----------	31 Marathon	1 Project	2 ----------	3 ----------	4 ----------
	5 ----------	6 ----------	7 Marathon	8 Project	9 ----------	10 ----------	11 ----------
	12 ----------	13 ----------	14 Marathon	15 Project	16 ----------	17 ----------	18 ----------
	19 ----------	20 ----------	21 Marathon	22 Project	23 ----------	24 ----------	25 Depart Marathon 0430 hrs.
SEPT	26 In Transit	27 In Transit	28 In Transit	29 Arrive CCIW 1400 hrs.	30 CCIW	31 CCIW	1 CCIW
	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW
	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 Depart CCIW 0900 hrs.	14 Arrive Port Stanley 1640 hrs.	15 Port Stanley
	16 Port Stanley	17 Dredge Impact Study	18 Lake Erie	19 In Transit	20 Dredge Impact - Study	21 Lake St. Clair	22 Windsor
	23 Windsor	24 Dredge Impact Study	25 Lake St. Clair	26 Depart Windsor 1530 hrs.	27 In Transit	28 Arrive CCIW 1635 hrs.	29 CCIW
OCT	30 CCIW	1 Depart CCIW 1410 hrs.	2 Lake Ontario Virology	3 Arrive CCIW 1030 hrs.	4 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
	14 CCIW	15 CCIW	16 CCIW	17 Hamilton Harbour NTA Monitor	18 CCIW	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 Lake Ontario Mycology	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 CCIW	30 CCIW	31 Depart CCIW 1610 hrs.	1 Lake Ontario Virology	2 Arrive CCIW 1118 hrs.	3 Depart CCIW 0910 hrs.
NOV	4 Arrive Port Stanley 1530 hrs.	5 ----------	6 Dredge	7 Impact	8 Study	9 Lake Erie	10 ----------
	11 ----------	12 ----------	13 ----------	14 ----------	15 In Transit	16 Erieau	17 ----------
	18 ----------	19 Lake Erie Coring	20 In Transit	21 ----------	22 Port Colborne	23 ----------	24 ----------
	25 ----------	26 Lake Erie Coring	27 Depart Port Colborne 1200 hrs.	28 Arrive Niagara-on the-Lake 0230 hrs.	29 Niagara-on-the-Lake	30 In Transit	1 CCIW
DEC	2 CCIW	3 In Transit	4 Lake Ontario Coring	5 CCIW	6 CCIW	7 CCIW	8 CCIW
	9 END	10 OF	11 CRUISES	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29

Table 8. Great Lakes Studies, 1973. M.V. LAC ERIE

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5	6
	7	8	9	10	11	12	13
JAN	14	15	16	17 NTA Monitor	18 Arrive CCIW 1245 hrs.	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1 CCIW	2 CCIW	3 CCIW
	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
FEB	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 Depart CCIW 0900 hrs.	20 NTA Monitor Arr. CCIW 1710 hrs.	21 CCIW	22 CCIW	23 CCIW	24 CCIW
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	1 CCIW	2 CCIW	3 CCIW
	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW
MAR	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 Depart CCIW 0900 hrs.	21 NTA Monitor	22 Arrive CCIW 1005 hrs.	23 CCIW	24 CCIW
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW
	1 CCIW	2 Depart CCIW 1040 hrs.	3 Field Trials	4 Field Trials	5 Field Trials	6 Arrive CCIW 1100 hrs.	7 CCIW
	8 CCIW	9 CCIW	10 Depart CCIW 0830 hrs.	11 Regional Sediment	12 Regional Sediment	13 Arrive CCIW 1330 hrs.	14 CCIW
APR	15 CCIW	16 CCIW	17 Depart CCIW 0900 hrs.	18 Field Trials	19 Arrive CCIW 1305 hrs.	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 0900 hrs.	25 NTA and Wave Rider	26 NTA and Wave Rider	27 Arrive CCIW 1110 hrs.	28 CCIW
	29 CCIW	30 Depart CCIW 0830 hrs.	1 Seismic Survey	2 Seismic Survey	3 Arrive CCIW 1750 hrs.	4 CCIW	5 CCIW
	6 CCIW	7 Depart CCIW 0905 hrs.	8 Met. Buoys	9 Met. Buoys	10 Met. Buoys	11 Arrive CCIW 2100 hrs.	12 CCIW
MAY	13 CCIW	14 Depart CCIW 1030 hrs.	15 Regional Sediment	16 Regional Sediment	17 Regional Sediment	18 Regional Sediment	19 Regional Sediment
	20 Regional Sediment	21 Regional Sediment	22 Regional Sediment	23 Regional Sediment	24 Regional Sediment	25 Regional Sediment	26 Regional Sediment
	27 Regional Sediment	28 Regional Sediment	29 Regional Sediment	30 Regional Sediment	31 Regional Sediment	1 Regional Sediment	2 Regional Sediment
	3 Regional Sediment	4 Regional Sediment	5 Regional Sediment	6 Regional Sediment	7 Regional Sediment	8 Arrive CCIW 2015 hrs.	9 CCIW
JUNE	10 CCIW	11 CCIW	12 Depart CCIW 0925 hrs.	13 Geophysical Survey	14 Geophysical Survey	15 Arrive CCIW 0145 hrs.	16 CCIW
	17 CCIW	18 CCIW	19 Depart CCIW 0850 hrs.	20 NTA Monitor, Arr. CCIW 1410 hrs.	21 CCIW	22 CCIW	23 CCIW
	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW
	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW
	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
JULY	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 0700 hrs.	25 Geophysical Survey	26 Geophysical Survey	27 Geophysical Survey	28 Arrive CCIW 2220 hrs.
	29 In Transit	30 In Transit	31 In Transit	1 In Transit	2 In Transit	3 Depart Port Stanley 1310 hrs.	4 Geophysical Survey
	5 Geophysical Survey	6 Geophysical Survey	7 Geophysical Survey	8 Arrive CCIW 0500 hrs.	9 Depart CCIW 0730 hrs.	10 Geological Survey	11 Geological Survey
AUG	12 Geological Survey	13 Geological Survey	14 Geological Survey	15 Geological Survey	16 Geological Survey	17 Geological Survey	18 Geological Survey
	19 Geological Survey	20 Geological Survey	21 Geological Survey	22 Geological Survey	23 Geological Survey	24 Geological Survey	25 Arrive CCIW 1230 hrs.
	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1
	2	3	4 OFF CHARTER	5	6	7	8
	9	10	11	12	13	14	15
SEPT	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	1	2	3	4	5	6
	7	8	9	10	11	12	13
OCT	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29	30	31	1	2	3
	4	5	6	7	8	9	10
NOV	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
DEC	16	17	18	19	20	21	22
	23	24	25	26	27	28	29

mote Sensing Section

The Remote Sensing Section is responsible for research d development in the field of remote sensing technology d the application of this technology to water manage- nt and lakes research.

The program includes studies using satellite-acquired ta (ERTS-1 and SKYLAB), as well as a variety of nventional and novel aircraft systems. In addition, earch is also conducted on the optical properties of the ter and the problems associated with the optical path m the water to an airborne sensor.

craft Programme

Two aircraft projects were carried out during 1973. e of these was a high altitude surveillance flight of ected areas in Lake Superior in conjunction with the .C. Upper Great Lakes water quality studies. In this oject both photographic and infrared imagery were tained in conjunction with surface and sub-surface water ality and water movement data collections. An example the infrared imagery is shown in Figure 28. Analyses of ese data will provide information on surface thermal tterns as well as turbidity characteristics in the Thunder y region, and are expected to be useful in interpreting urces and movements of pollutants.

The second project involved a series of overflights to llect digital infrared imagery of the power plants along e north shore of Lake Ontario. These data have direct plication to the thermal plume studies carried out by the eat Lakes Biolimnology Laboratories. Preliminary analy- shows that the digital scanner data provide a good presentation of the surface temperature structure of the ermal plume.

tellite Studies

gital Analysis of ERTS-1 Data: Computer techniques ve been established for the handling and processing of mputer-compatible ERTS-1 tapes supplied by both the nada Centre for Remote Sensing in Ottawa and the ROS Data Center in Sioux Falls, Idaho. This has enabled a vector spectral classification of the reflectance responses m the water masses, comprising the Great Lakes System the basis of the energy return from the surface recorded the ERTS Multispectral Scanner on a geographic scale of 50 ft. Work done thus far on data collected over the eat Lakes and interconnecting river systems has shown at:

a) Distinct and statistically reliable optical reflectance regimes exist on the surface of the water in a manner conducive to mathematical pattern recognition studies.
b) Excellent resolution (of a few hundred meters) is possible in almost all cases on both a per-band and combined-band basis.
c) The presence of turbidity (due to either the presence of suspended particulate matter or to water color differences) acts as an excellent diagnostic aid to evaluation of lake dynamics, particularly in Band 4 ($0.5 - 0.6\mu$). Under certain conditions,

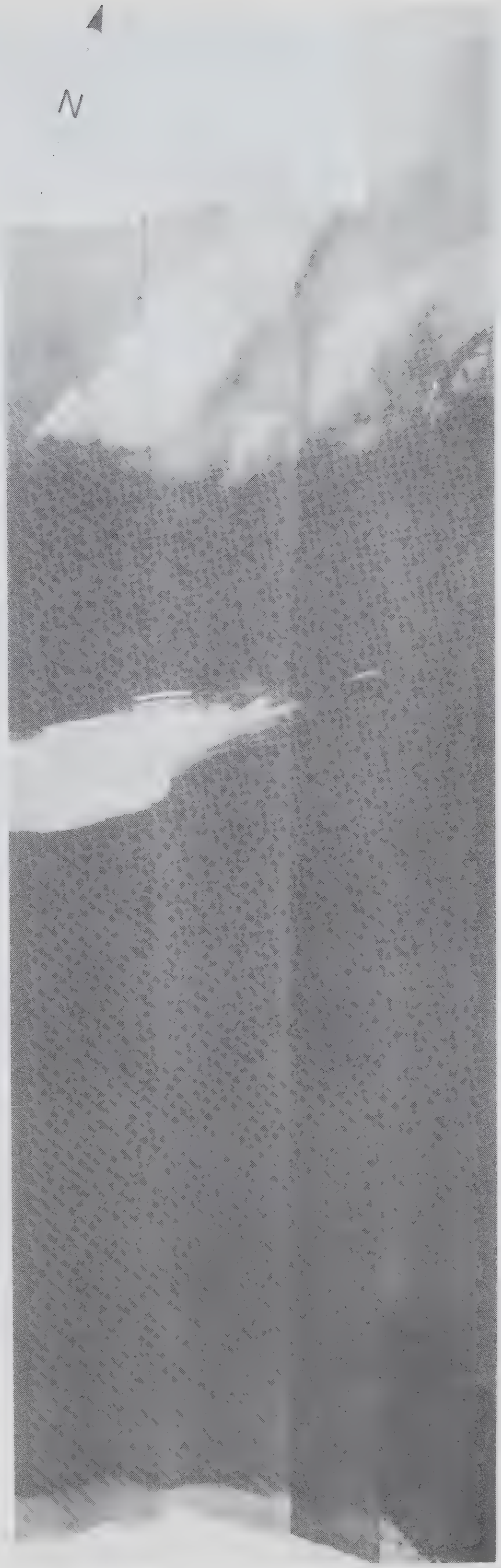


Figure 28. Lake Superior, Thunder Bay to Keweenaw Peninsula. RS 73-11, June 24, 1973, 1730-1830 E.D.T., Lines 5-8, Altitude 34,000 ft.

Figure 29. Lake Ontario – ERTS-1 computerized print-out of western Lake Ontario, August 21, 1972, band 4 (0.5-0.6 μ).

ERTS may provide a synoptic review of the internal dynamical features governing the lake behaviour.

Figure 29 illustrates the computerized print-out (maxi-m spectral resolution; 1/42 maximum spatial resolution) the western basin of Lake Ontario as recorded by ERTS Band 4 on August 21, 1972. Figure 30 illustrates the nputerized print-out (1/4 maximum spectral resolution; /4 maximum spatial resolution) of the sediment trans-t off Point Pelee as recorded by ERTS in Band 6 (0.7 — μ) on March 27, 1973.

During the past year, a number of studies on the erpretation of ERTS data were carried out under ntract. In general, these studies involved limnological estigations in small lakes at various locations (Table 9) oughout Canada.

-Glint Studies of Lake Ontario: Using high altitude 3-57 ERTS-Simulation data in conjunction with concur-et CCIW-CCRS intermediate altitude data collected in ie, 1972, relationships between lake surface solar reflec-i properties and dynamics occurring within the lake have en strongly suggested. In particular, a detailed analysis been performed which shows the role of sun-glint in neating the dynamics related to upwelling activity.

a Retransmission via Satellite

The ERTS-1 data collection platform (DCP) program continued in 1973. During this past field season, the P, which relays data from the collector system to a shore eiving station via the satellite, was mounted on a tower 20 metres of water off Fifty Mile Point in Lake Ontario.

Table 9. Studies of ERTS Data

tly title	Agency
1 Application of satellite imagery to he inventory of the surface and round water patterns in the Cooking Lake and Gull Lake basins in Alberta, Canada.	University of Alberta
2 Application of satellite imagery to he study of the St. Lawrence Valley area in particular Lake St. Louis and Lake St. Pierre.	Centre de Recherches sur l'eau, Université Laval
3 Application of satellite imagery o water mass delineation of vestern Lake Ontario.	Erindale College, University of Toronto
4 Application of ERTS imagery to he study of the ice regime on Lake Erie and the reservoir reas above the Churchill Falls power development in Labrador.	H.G. Acres Consulting Services Limited
5 Application of satellite data to reeze-up, break-up and changing configuration of lakes in northern Quebec and Labrador.	McGill University
6 Application of satellite imagery o the study of Big Quill Lake.	Saskatchewan Research Council

Solar radiation and under-water optical parameters were measured. A digital integrator system was designed and constructed at CCIW, as an interface for these parameters. The integrator was a self-resetting type, taking some three days (under average conditions) to fill and reset. This type of integrator can be used with any analog or digital signal in the range of one millivolt to one volt.

The data will be used, along with the lake monitor optical data, to describe the optical conditions of Lake Ontario.

An application of National Oceanographic and Atmospheric Administration has been approved for CCIW to participate in the "GOES" satellite program, commencing in 1974. GOES is a geostationary satellite which will provide opportunities for more continuous data relay.

Remote Detection of Oil

In conjunction with the Environmental Emergencies Branch's Centre of Spill Technology at CCIW, the Remote Sensing Section has undertaken a study into the application of remote sensing technology to the detection of oil spills. Work on a comprehensive state-of-the-art report will be completed by June 1974.

Lake Optical Studies

During 1973, a lake optical program was continued and expanded. A new transmissometer which measures the *in situ* attenuation coefficient, was tested early in the year. Data from this instrument can be expressed as an attenuation coefficient or a percentage transmittance and can provide a vertical profile of these parameters if measurements are made as a function of depth. These measurements are now carried operationally and the data have provided information on water mass characteristics and water movements. The data have also helped locate unexpected biological activity at depths of 20-30 metres in Lake Superior. Figure 31 shows typical data derived from this instrument.

Other optical data collected during the surveillance cruises include upwelling and downwelling irradiance and colour indices. The colour index is simply a ratio of the upwelling irradiance at two wavelengths. The colour indices were measured with an experimental colour index meter designed by the Remote Sensing group. The colour index data obtained from this instrument is encouraging and the main turbid areas and current patterns of Lake Superior are well defined by these measurements. The irradiance measurements using an *in situ* spectrograph have been used as a check on the colour indices and also to examine the characteristics of the *in situ* upwelling and downwelling colour and its relation to limnological parameters.

During the past year, work on a marine Lidar system under contract to York University was initiated. In the early phase of this programme, laboratory measurements in the CCIW indoor towing tanks were performed to assess a number of Lidar system characteristics. Subsequent field trials, on board the CSS LIMNOS in August 1973, in Lake Erie have yielded more information on the present system. In the indoor tanks, penetration ranges up to 20 m have been achieved and in the lake, under typical wave condi-

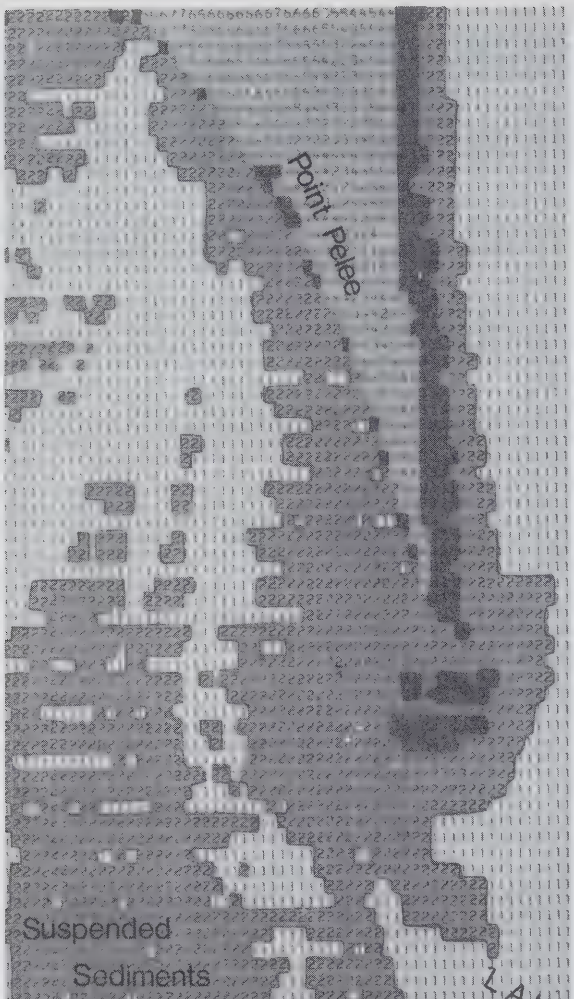


Figure 30. Point Pelee – ERTS computerized print-out of suspended sediments transport in the Point Pelee – Pelee Island area, March 27, 1973, band 6 (0.7-0.8 μ).

tions, penetration depths of up to 8 m have been recorded. Possible future direction of this work may lead to an airborne system which measures the attenuation coefficient at a number of wavelengths.

Data Management Section

The Data Management Section is responsible for planning and operating the CCIW Data Archive (which includes the Canadian IFYGL Data Bank), making data available to users requesting it, providing data processing support for CCIW projects, and preparing special scientific publications and reports.

Three units comprise the section: (1) Computer Applications Unit, which develops and maintains computer software, provides data archiving and management software, provides common user or "library" computer programmes, provides consulting services, and direct project support; (2) Data Archives Unit, which processes and edits certain groups of data (vessel surveys), maintains the CCIW Archive for scientific, socio-economic and engineering data, maintains the Canadian IFYGL Data Bank, and services data requests originating from within the outside CCIW and (3) Special Projects Unit, which provides direct support to projects within CCIW, and produces descriptive scientific reports for the public and scientific community, for the Great Lakes system.

During the year, a total of five internal projects were carried out, including maintenance of the Canadian IFYGL Data Bank, development of an initial library of common user computer programs, development and enhancement of a storage/retrieval system for the larger data bases, as well as the development of computer display packages to generate films for micrometeorological studies and the prediction of oil slick movements. In addition, direct programming, technical and clerical support was given to 5 CCIW projects.

The C.C.I.W. Data Archive was reorganized and streamlined during the year and a working group was started in October to design a master plan for the archive and user services. The Canadian IFYGL Data Bank was kept operating at a high level, and acquired a large volume of data primarily from Canadian IFYGL projects. In addition, 8 official external requests were received for non-IFYGL data, and 53 for IFYGL data, as well as 410 internal data requests. During the autumn, a proposal for a policy on data archiving and data release to users, was submitted to C.C.I.W. management. This policy covered what data was to be archived, general procedures for archiving and when it would be archived. In the area of data release, it covered the availability and accessibility of data in the archive, to C.C.I.W. and other users. Quality controls on data were tightened and streamlined, with the final and more detailed procedures for wider classes of data planned for development in parallel with the master plan for the archive.

A major component of internal software development was in the data management for the archive. This included streamlining and conversion of the STAR and TSA storage and retrieval systems, and the initial design for STORET to STAR data conversion package. Assistance wa

TRANSMITTANCE (%) AT A DEPTH OF ONE METRE

Figure 31. Typical data derived from the Market Model XMS Transmissometer Wratten 45 Filter.

iven to the Water Quality Branch for contract programhing for a STAR to NAQUADAT conversion package. \dditional software was written for the storage of a large ariety of data; in the majority of cases, the data were ewritten to conform to the requirements of the standard ata management systems: STAR – scientific data obtained rom scientific vessels; TSAR – time series data; SAFRAS - geological and socio-economic data. In addition, the first xtensive edition of a CCIW Computer Programme Library vas produced for users.

An initial set of descriptive reports, one for each of the our Great Lakes immediately adjacent to Canada, was roduced. These were the prototypes of reports planned to e issued regularly in 1974, for each vessel cruise.

A large component in the total activities of the Data Management Section, was the provision of supporting ervices to CCIW projects. This encompassed programming ervices, clerical assistance, and the provision of technical ssistance for scientific projects.

COMMITTEE MEMBERSHIP

Bukata, R.P.
- Secretary to CACRS Working Group on Limnology
- Member of Near Shore Zone Task Force, CCIW

Durham, R.W.
- Ad Hoc Committee on Water Quality Objectives for Radioactivity in the Great Lakes – Member
- Working Group on Uranium Mining and Milling Effluents – Member

Dutka, B.J.
- Committee D-19. The use of membrane filters in bacteriological examination of water. American Society for Testing and Materials
- Committee on Interservice Co-ordination of Analytical Laboratories, Ontario Region
- ICW Working Group on Water Quality Networks

Lane, R.K.
- Canadian Co-Chairman, IJC Upper Lakes Reference Group
- Member of Canada-Manitoba Lake Winnipeg Limnological Working Group
- Chairman, CACRS Working Group on Limnology
- Member, Board of Directors, International Association for Great Lakes Research
- Member of the Subcommittee on Hydrology (Associate Committee on Geodesy and Geophysics)
- General Chairman, American Water Resources Association 1973 Symposium

Lowe, W.E.
- Scientific Operation Division Safety Committee

Prantl, F.A.
- Working Group on Hydrology of the Canadian Advisory Committee for Remote Sensing – Member

Rao, S.S.
- CCIW Great Lakes Surveillance Committee

Thompson, K.P.B.
- Programme Chairman and editor of the proceedings of the International Symposium on Remote Sensing of Water Resources, held at CCIW, June 11-14, 1973.
- Member of Programme Committee and Session Chairman of Limnology and Oceanography for the 2nd Canadian Remote Sensing Symposium, to be held at Guelph, April 1974.
- Secretary to the CACRS Working Group on Limnology

Weiler, H.S.
- Monitor Surveillance Committee – CCIW
- Field Year – Joint Management Team
- Department of the Environment EDP Committee

AWARDS

Bukata, R.P. – Co-recipient of NASA Group Achievement Award for contributions to the Pioneers 6, 7, 8 and 9 deep-space probe missions.

SCIENTIFIC SUPPORT DIVISION

The Scientific Support Division provides the major portion of the technical, professional and administrative support for the scientific programmes at the Centre, as well as some applied research and development in instrumentation. It consists of three sections, the activities of which are described below.

SCIENTIFIC SERVICES

This section is comprised of three units: Instrumentation Research and Development, Computer Services and Library Services.

Instrumentation Research and Development Unit

This Unit was created in April, 1973 with the appointment of an engineer and the outfitting of a small wet chemistry laboratory. Its mandate is to develop immersion sensing technology, giving particular attention to the needs of the chemical and biological areas of the work at C.C.I.W.

A major component of this group's effort has gone to the development of what is now called the Robot Experimenter System (REX). Conceived as a new type of water quality monitoring system (K. N. Birch, M. Sci. Thesis, 1973), the system is being designed as an in situ workbench to aid in the development of new sensor technology and, eventually, new and improved sensors. It will consist of a submersible station, made up of apparatus and interface modules; and a shore station, housing a minicomputer. The apparatus modules are being specifically engineered to work under water and under computer control. Designs are now completed on a series of electrode-flow cell modules, an eight point distributing valve and a series of reagent and sample pumps. It is expected that an operational prototype system will be completed by the end of 1974 summer.

A research contract was awarded to Dr. K. B. Oldham of Trent University for developmental work on a novel dissolved oxygen sensor for long-term monitoring applications, plus conceptual development of a humidity sensor and a low speed, current meter based on an electrochemical principle. Early indication is that the concept for the dissolved oxygen probe is practical, but additional work will be needed to realize accuracy and sensitivity at the sub-ppm level.

During the latter part of the field season, Instrumentation R & D sponsored two pilot evaluation trials for commercially available instrumentation. In one of these trials a set of three instruments (a fluorometer sensitive to Chlorophyll a, a Keen ratiometer turbidity meter, and a U.V. absorption meter for dissolved organics) was arranged to continuously monitor the surface water along the track of a ship. The data which resulted showed interesting variation in these optical properties between the usual monitoring stations. In another trial, an InterOcean probe that measured temperature, pH, conductivity, dissolved oxygen and light transmission against depth was evaluated.

Computer Services Unit

The Computer Services Unit has the responsibility fo operating and providing software support for the majo computer systems at C.C.I.W., as well as a keypunch servic and technical consultation in areas pertaining to electroni computers.

The major accomplishment of 1973 was the upgradin of the Control Data (CDC) 3300 computer with 32,76 words of memory and serial batch processing capability, t a CDC 3170 computer with 98,304 words of memory expanded disk storage, a faster line printer, and th capability of multi-programmed operation (the concurren processing of several jobs). The proposal for this upgradin was approved in August; site preparation completed i September, and installation of the new hardware occurre in October and November. During this period, extensiv software development took place so that, on Novembe 19th, the CDC 3170 computer with the MASTER operatin system was placed in regularly scheduled operation. At thi time all special system software was available for th transfer of existing programmes. For the remainder of th year both the MASTER operating system and the ol system (MSOS) were available each working day so tha production work continued while programme conversio took place. On December 31st, MSOS was used for the las time, and full time use of MASTER was initiated in the nev year.

During 1973 a total of 33,019 jobs were run under th MSOS system, which utilized 1,767 hours of elapse computer time and required the mounting of 18,36 magnetic tapes. In addition, 3,761 jobs were run unde MASTER, which utilized 76.1 hours of central processo time and required the mounting of 2,602 tapes. combined total of 36,780 jobs were run during 1973.

In addition to the CDC 3170 computer, the Unit has DEC PDP-8 computer used to reformat instrumentatio tapes to computer-compatible magnetic tape and a large DEC PDP-15 is used for special applications such a plotting, analog-to-digital conversion, interactive graphic and the production of motion-picture data displays.

A terminal connected to Multiple Access Limited i Toronto was operated during the year for the running o jobs which were too large for the in-house facility However, with the expansion to the CDC 3170 system, thi service is no longer required and it was terminated at th end of December.

Library Services

The Library support of C.C.I.W.'s expanding researc programme was hindered somewhat this year by the grea increase in the cost of publications, which necessitate trimming our journal subscriptions and book purchase Inter-library loan requests increased to 3,470 during th year. In computerized information retrieval, several ne scientists were assisted in compiling computer interes profiles and many retrospective searches were conducte

for C.C.I.W. scientists on several data bases during the year. The library staff compiled a bibliography of C.C.I.W. staff publications and published it, as well as Volume 5 of our Collected Reprints.

ENGINEERING SERVICES

The Engineering Services Section provides engineering support services on request to all other sections, groups, and divisions at C.C.I.W. These services range from innovative design and development engineering, through various equipment modification and improvement programmes, to preventive and corrective maintenance performed on the substantial and increasing C.C.I.W. environmental instrument inventory. This support is centred around a professional design engineering capability in the technological fields related to inland waters instrumentation and equipment, and also features technical drafting, equipment testing, calibration and machine shop prototype manufacture.

Shown in the Summary Table 10 is a listing of those C.C.I.W. instruments, equipments, or environmental data-gathering systems which required during 1973 sufficient engineering support to be considered as a major engineering activity or project. This listing comprises a book value of several million dollars worth of equipment. A brief description of the engineering support given to the larger programmes in 1973 is provided here. Also shown are photographs illustrating some typical instrumentation or equipment installations.

Table 10. Summary of Engineering Systems, Projects, and Instrumentation

Moored Metbuoy Systems, with Sensor.
Moored Current Measuring Buoys (approx. 20 locations).
Shoreline BT Stations (quantity 7 systems installed).
Air/Water Interaction Instrumentation (2 Towers/Turbulence & Profiling).
Moored FTP System. Technical Evaluation Programme.
Wind/Wave Flume Data-Acquisition System. Definition Phase.
Monitor Printout Unit Refurbishment Programme (quantity 10).
Recorder System for Micromet Application.
In Situ Fluorometer (Improvement Programme).
Environmental Data Storage Modules (Study & Survey).
Programmed Fluorescent Dimming System (for EPS Bioassay).
Modified Timer (for 1973 ERTS Satellite Program).
Nearshore Monitoring Facility (System Definition/Preplanning).
Ship's EBT Systems (various – approx. 10 plus spares).
Submersible Electronics Package Design.
Auto-Programmer for CO_2 Monitor System (Quinte/Burlington).
Digital Timecode Generator Module (quantity 6).
Acoustic Bottom-Detector/Camera System.
Solid-State Temperature Sensor Module.
Auto-Programmer for DO-Profiling Winch System (Quinte).
Electromagnetic Current Sensor (Procurement Programme).
Digital Integrator (for 1973 ERTS Satellite Programme).
C.C.I.W. Acoustic Release Units.
Sediment Transport/Tracer System (quantity 1).
C.C.I.W. Data-Translator (for Plessey/Geodyne Tapes).
Sediment Settling Tube Pressure Recording System (quantity 2).
Solid-State Depth Sensor Module.
FRB Fish Counting System.
Towed Temperature-Profiling Digital System.
Solid-State RH Sensor Module.
Ship's "Data Acquisition Systems" (quantity 2).
Aquatic Biota Photo Stimulation System.
C.C.I.W. Towed Body (Batfish) System Engineering.
Water Re-aeration Flume (Hydraulics).
Instrument Carriage and Data Acquisition – Wind Wave Flume (Hydraulics).
Frazil Ice Flume with Wave Maker (Hydraulics).
New Corers – MKII Triple Corer, Mini-Shipek Corer, Water-Jet Beach Corer, Soft Mud Sampler.
Horizontal Electric-Drive Core Extruder and Core Slicer.
Oil/Water Emulsification Hydrophil Balance.
Ship's Pumping Systems – Heavy Duty Water Monitoring.
Reverse Osmosis Membrane Apparatus.
Interstitial Water Squeezers and Electrode Potential Cells.
MKII Plankton Incubator Using Carbon 14 Technique.

Moored Temperature-Profiling Buoy Systems

The engineering support applied to these systems in 1973 was in three main phases. The first phase involved the analysis and elimination of the residual system problems noted during IFYGL (1972). The special Fixed Temperature Profiling (FTP) cable assembly received design improvements in conjunction with industry and consultants; extensive in-house cable endurance and flex tests were run (Figure 32); improved logic was incorporated in the FTP electronic digitizers; and sensor alignment problems were solved. The second phase (mid-year) was a multi-month field technical evaluation programme in Lake Huron which was successful. Finally, a winter operational moorings pro-

Figure 32. Moored FTP system being deployed.

gramme was conducted with an "inverted under-ice" buoy system configuration . . . . a first for C.C.I.W. Post-'73 utilisation of these profiling systems in British Columbia lakes and elsewhere is expected to increase considerably.

Air/Water Interface (Micromet) System

During 1973 the C.C.I.W. instrumentation system used for boundary-layer studies (which in 1972 was wholly deployed offshore at Niagara) was substantially reconfigured and deployed in the nearshore Hamilton area. Two towers mounted the sensor instrumentation (Figure 33), power and data cables were laid to the beach, where a trailer site held the data-logging instrumentation. Although storms and accidents damaged the tower structures, useful time-series data were recorded. Also the boundary-layer measuring was extended to the 1000 feet height, using specially modified tethersonde radiotelemetry instrumentation.

C.C.I.W. Acoustic-Release Units

Longstanding problems with C.C.I.W.'s various acoustic-releases, used for freeing moorings on command, were technically analysed during the year, their faults diagnosed, and a technical-upgrade programme implemented with industry and successfully performed on the best-designed unit (Figure 34). Other releases not offering potential for long-term satisfactory operation were phased out from C.C.I.W. inventory. Extensive winter under-ice deployment of these improved releases followed.

Moored Metbuoy Systems

These now well-proven C.C.I.W. systems for over-lake meteorological measurements received extensive use during 1973 in Lake Superior, Huron and Ontario, Lake of the Woods, Bay of Quinte, the St. Lawrence, in both summer and winter (Figure 35). The necessary maintenance and testing of the 22 instrumented systems is contracted to Canadian industry.

Dissolved-Oxygen Auto-Profiler

In connection with the Bay of Quinte limnocorral experiments, an automatically controlled winch profiler was designed, which sequentially profiled a dissolved oxygen probe through the water column in each corral in turn once per hour. A view is shown of the special winch engineering for this system (Figure 36).

Simulated Radiation System

During the year a second auto-controlled light simulation system for lab use was manufactured and installed in the E.P.S. bioassay laboratory for studying the effects of simulated daylight on algae specimens. Of interest was the overall development sequence, where Canadian industry, with little difficulty, produced the second needed system in 1973, after C.C.I.W. staff had developed the first prototype in 1972.

Temperature/Depth Profiling (EBT) Systems

This equipment area is one of the many where equipment mix and diversity requires and consumes far too much technical effort. Accordingly in 1973 emphasis wa put on logistic rationalization, with separate programme conducted to upgrade and standardize the various sensin probes and winches of this system. The EBT probes wer then improved and standardized (Figures 37 and 38). Th prototype EBT winches used on Limnos and Martin Karlse are being replaced by advanced design heavy-duty unit Three more winch systems are also being prepared for us on launches.

C.C.I.W. ERTS-Satellite Radiation Monitoring System

Engineering Services participated in the establishmen of this tower-based radiation monitoring system by deve oping solid-state digital-integration facilities for the variou solarimeters used. This system represented the secon application of ERTS Satellite technology at C.C.I.W.

Moored Current Measuring Buoys

About 150 deployments of C.C.I.W. self-recordin current meters at inland waters moored stations wer provided in 1973 in support of various water-movemen studies. All refurbishment, preparation, testing and calibra tion of this equipment is contracted to Canadian industry Between 200 and 300 field-data and test-data tapes wer routinely translated during this work.

Auto-Sequencer for CO_2 Monitor

Engineering support was provided in 1973 in th creation of a tower-based automatic atmospheric CO monitor system for lake use. This system featured conside able piping, valves, pumps, solenoids, gas sources, equilibra tor, etc., as well as the CO_2 analyser itself. The differen system modes-of-operation each required a pre-set cycle o activation of these components, and to control and tim the operations correctly, a solid-state diode-matric s quencer assembly was designed and built, as shown i Figure 39.

Integrated Electronic Instrument Packaging Technique

Analysis of C.C.I.W. electronic engineering develop ment activities of recent years had shown very considerab effort spent in evolving specially packaged electron assemblies for specific projects, using various sub-assembl physical formats. To provide more rapid prototypes o electronic equipment for C.C.I.W. programmes some effo was applied in 1973 to rationalizing the overall approach t the packaging problem. For this work an integrated seri of standard packages has emerged (Figures 40, 41, 42 an 43), where the same standard components, parts, integrate circuit boards, etc., are consistently used, whether fo submersible electronic packages, for rack-mounted chass assemblies, or for smaller bench-type instruments. High development productivity should stem from this approac

Acoustic Fish Population Density Monitoring

Engineering support was given early in '73 to modif ing and testing G.L.B.L.'s measurement system for assessi the fish biomass component. This relatively simple acoust sounding system was used in Lake Ontario with promisi results. Later in the year, significant design effort w

Figure 33. Air/Water Interaction Programme profiling subsystem.

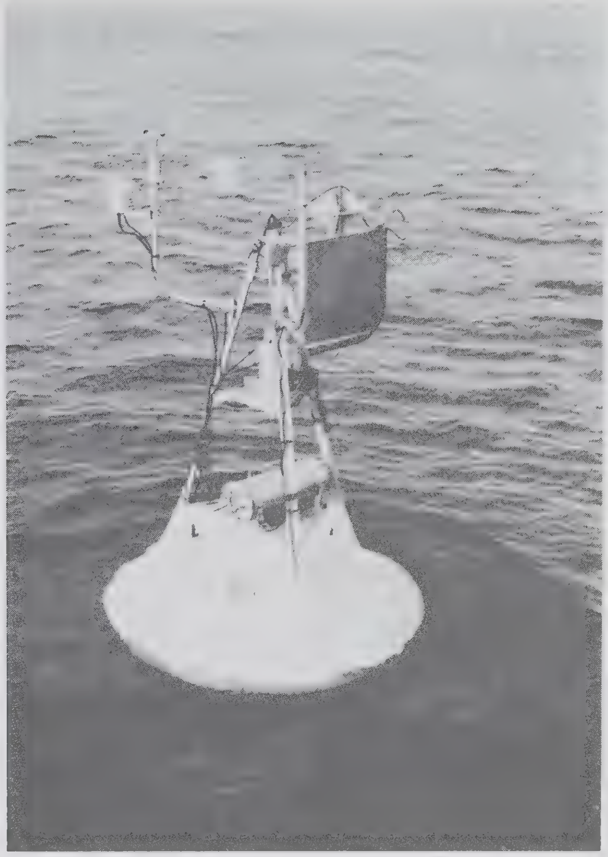


Figure 35. Metbuoy system with sensors (winter mooring).

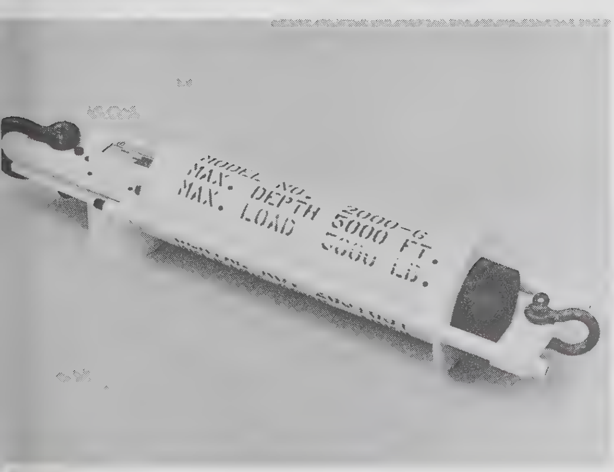


Figure 34. Acoustically triggered underwater release unit.

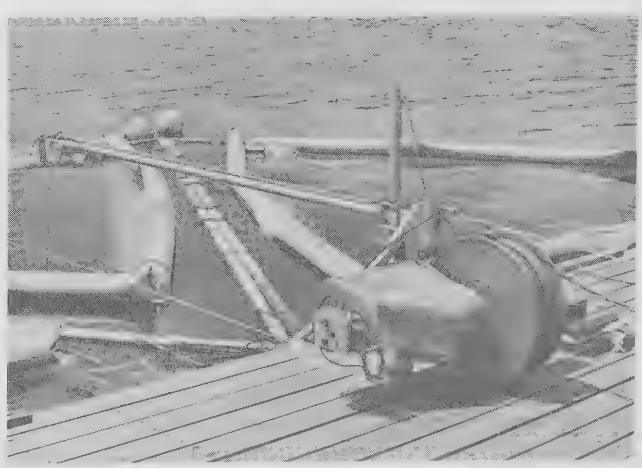


Figure 36. Dissolved oxygen profiling winch installed at limnocorrals.

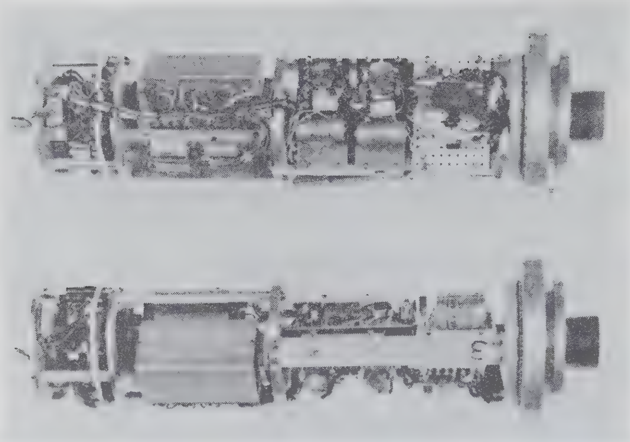


Figure 37. EBT probe (1971 model, prior to rework).

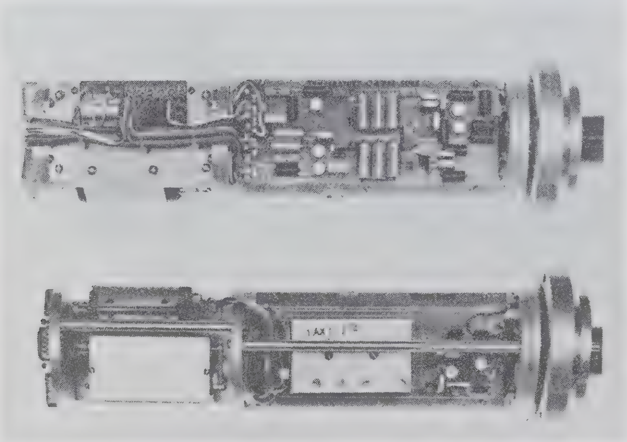


Figure 38. Reworked/repackaged EBT probe (1973).

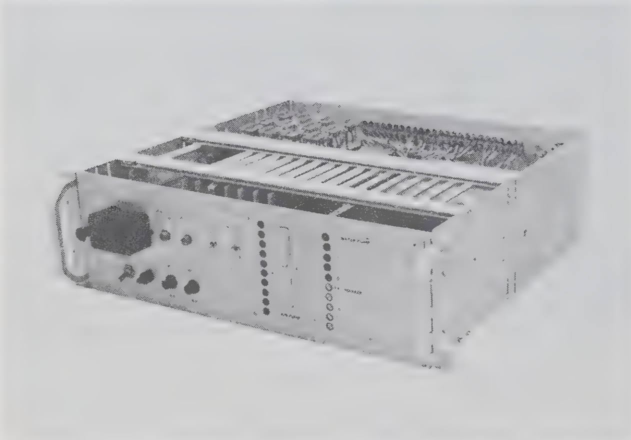


Figure 39. Auto-sequencer for CO_2 monitor system.

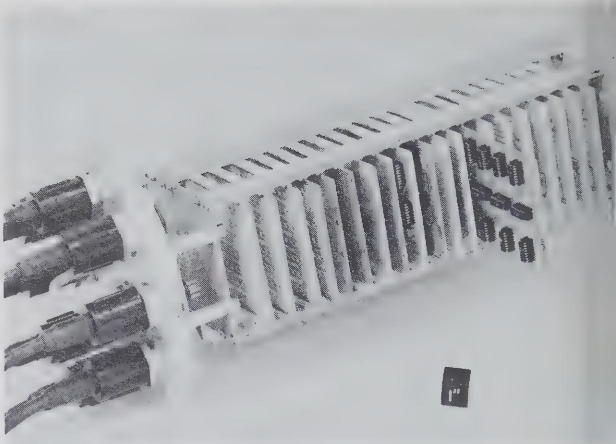


Figure 40. Submersible electronic instrumentation package.

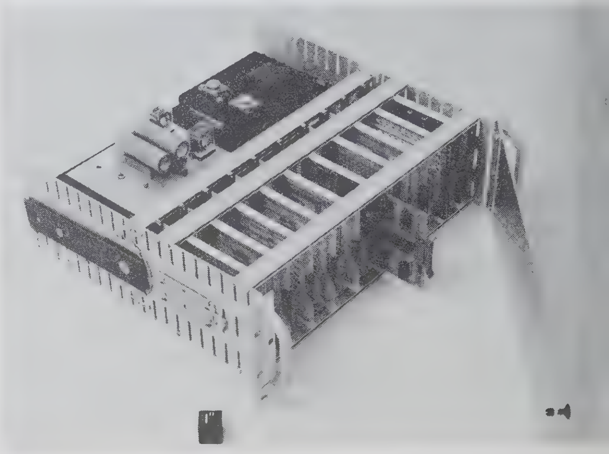


Figure 41. Rack-mounted electronic instrumentation package

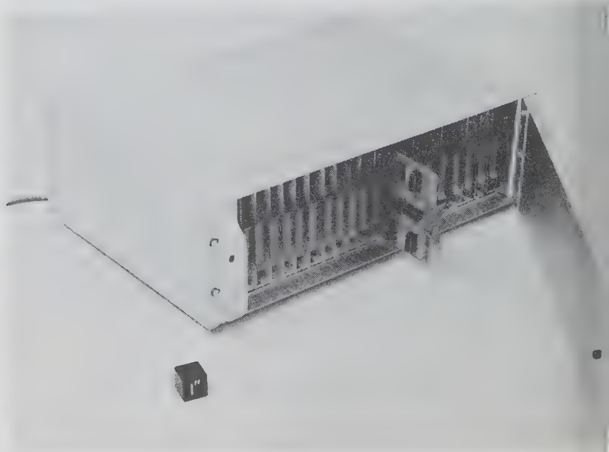


Figure 42. Lab-type bench instrumentation package.

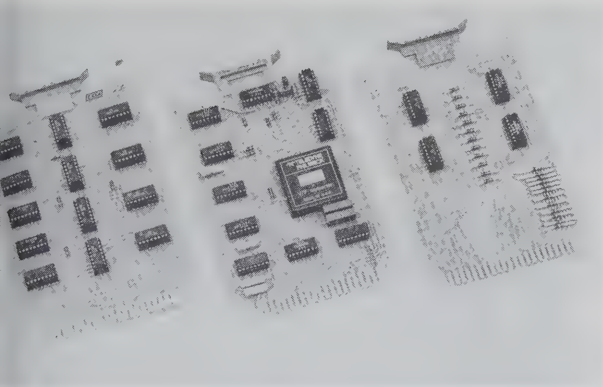


Figure 43. Standard integrated circuit PC card modules.

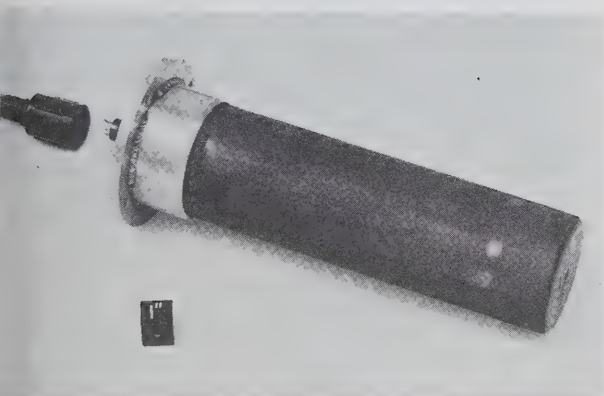


Figure 44. Electromagnetic water velocity sensor module.

Figure 45. Underwater pressure sensor module.

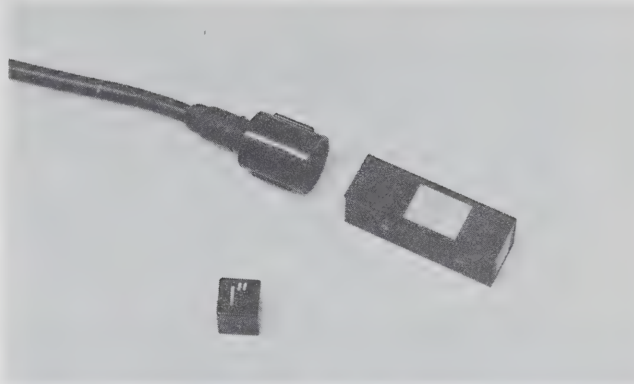


Figure 46. Platform direction sensor module.

directed to evolving an improved acoustic fish echo analysis system for obtaining much more accurate data on inland waters fishstocks and their variations and distribution.

Underwater Cable Systems

C.C.I.W., with its many inland waters measuring systems, has continuing heavy investment in specially engineered underwater cable systems. In fact, present cable assembly inventory totals over $150,000. Although all cable assembly manufacture and special testing (such as hipoting, pressurizing, TDR, stressing and X-raying) is done by local industry, considerable engineering support in terms of cable assembly design definition and procurement specification is provided each year. In 1973, as a routine activity, seven separate cable design specifications were engineered, and about 20 cables of $40 K value procured for this year's programmes.

Environmental Sensor Engineering

Some limited work was done in 1973 towards the target of having in C.C.I.W. operating inventory, a range of relatively standard, easily interchangeable sensor modules, use of which could substantially ease the considerable effort presently required to synthesize and assemble environmental monitoring systems. Figures 44, 45 and 46 show certain prototype solid-state sensor modules for measuring some of the specific environmental parameters such as water speed, ambient pressure, relative humidity, temperature, atmospheric pressure, fluorescence, conductivity, platform direction, wave amplitude, etc.

Aquatic Biota Photo-Stimulation System

Design engineering commenced late '73 for the development of a flexible controlled illumination system used in studying the responses of biotic specimens by G.L.B.L. This system will feature wide light intensity range, varying radiation incidences, and different chromaticity modes.

Reverse Osmosis Membrane Apparatus

A special membrane casting apparatus was designed and manufactured by Engineering for the Water & Wastewater Research Subdivision. Figure 47 shows the system

which consists of:

- a water bath with temperatures adjustable within -10° to $50^\circ C$ to an accuracy of $\pm 1/2^\circ C$,
- a temperature controlled plate for casting of membranes,
- a gelation cold temperature bath with mechanised feed,
- manufacture and installation of membrane pressure cells consisting of 2 bands of six dynamic cells and two static pressure cells.

Since volatile materials such as acetones and ethers are now being considered in the testing solutions for manufacture of membranes, the system has been modified to give total explosion proofing.

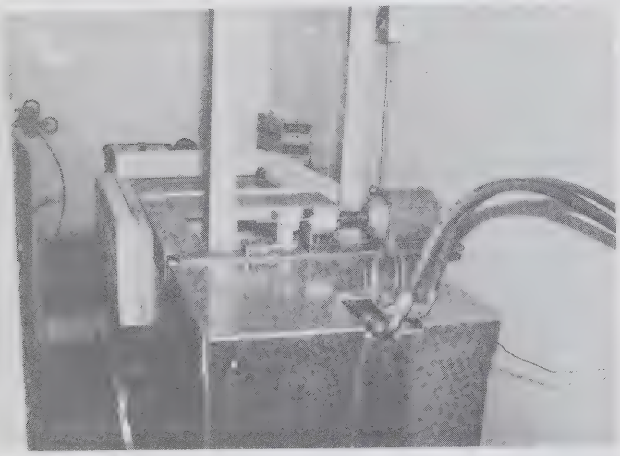


Figure 47. Reverse osmosis membrane manufacturing apparatus.

Assistance to Hydraulics Division

The design and project control of a 104-foot long tilting re-aeration flume was done by Engineering (Figure 48). This flume is a recirculating type with a 60 cm wide trough and is now used for research into the process of atmospheric re-aeration in open channels (see report of Hydraulics Division). An ice flume has also been designed for use in the newly constructed cold room. Engineering Services designed and constructed the apparatus to generate continuous sinusoidal waves at adjustable frequencies and amplitudes with adequate damping, as well as methods to prevent ice forming on the equipment of the flume.

Maintenance, Repair, and Calibration of C.C.I.W. Instrument Inventory

As in previous years, a large portion of Engineering Services support to research programmes at C.C.I.W. took the form of maintenance of the substantial and increasing inventory of environmental instruments and electro-mechanical equipment, totalling more than 1200 items. The term "maintenance", of course, encompasses incoming inspection; preventive maintenance; equipment modification and improvement; corrective maintenance such as fau diagnosis and equipment overhaul; performance testin instrument calibration; and considerable contract supe vision. The C.C.I.W. common-user inventory to be mai tained increased in 1973 to approach 3 million dollars i value.

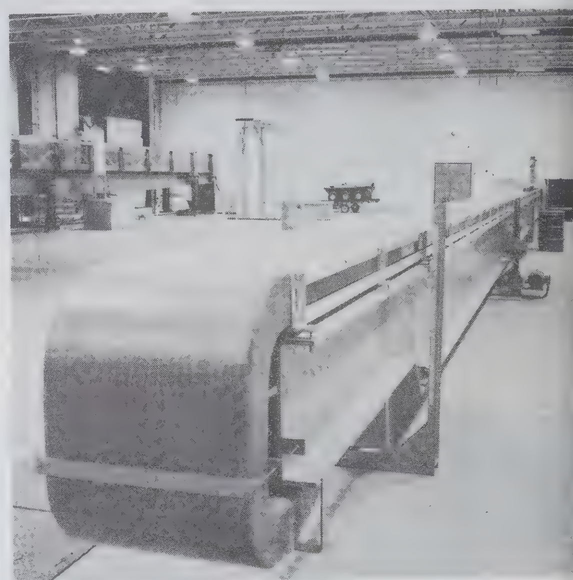


Figure 48. Hydraulics Division's tilting re-aeration flume.

Because the C.C.I.W. maintenance staff compleme did not increase during the year, but both the amount a age of the instrument inventory did, the increased mai tenance load was handled by augmenting our contra maintenance programmes with Canadian industry. Duri the year, approximately $250,000 in maintenance ty contracts were placed with industry and technically mo tored by Engineering Services staff, embracing such sta dard environmental instrumentation items as:

Current Meters	Digital Data Loggers
Temperature Probes	Teletypes
Resistance Digitizers	Humidity Sensors
Fluorometers	Radiation Sources
Special Winches	Digital Test Units
Chart Recorders	Cable Assemblies, etc

STAFF SERVICES

A new Centralized Procurement and Accounti System was implemented during the year. The syst provides three basic integrated services viz. procureme financial accounting, and their required typing and cleri support. This system has relieved scientists and technici of an increasingly heavy administrative workload and at same time has enhanced the quality of service provided.

SOCIAL SCIENCES RESEARCH

It is the responsibility of this group to review and velop balanced water resources management policies and ograms, specifically as they relate to the regional and the tional program responsibilities of CCIW and its research d regional activities. Disciplines of economics, sociology, ography and political science are represented, and these fferent perspectives are combined to formulate and carry t socio-economic studies. More specifically, the research jectives are:

- to provide a comprehensive and detailed socio-economic data base, covering the Great Lakes Basin, in support of quantitative analyses for policy formulation, and for the assessment of the economic impact of proposed water management policies on the regional economy.
- to investigate and assess the costs and benefits of existing practices, procedures, and operational systems used in water resources management, and to recommend more suitable alternative solutions.
- to investigate and analyse public and officials' perceptions of, and attitudes towards water resources issues in general, and specifically as they relate to problems encountered in the Great Lakes Basin water management. To recommend changes in water management policies so as to incorporate notions of public perceptions and attitudes.
- to analyse legislation, institutional arrangements and practices insofar as they affect specific water resources management problems, and to recommend improvements.
- to assess the impact of water resources research, its diffusion and innovative applications, on water resources management.
- to develop analytical and systems modelling techniques to allow quantitative estimates of the complex interrelationships between human activities and water quality, and to assist in forecasting the changes in these interrelationships.

The year 1973 was an active year for this group. A new ad was appointed, and there was an increase in staff, as ll as several staff changes. Each professional staff mber undertook several individual research projects, and o participated in joint projects with other divisions, partments, and government agencies. Staff members rticipated in work of the International Joint Commission's Upper Lakes Reference Group, the International int Commission's Land Drainage Reference Group, the nada-Ontario Great Lakes Shore Damage Survey, the tional Library/Treasury Board Committee for Application Centres for Scientific Information. Staff members also rticipated in the work of several of the committees of ganization for Economic Co-operation and Development, preliminary Economic Study on the Extension of Navigation Season in the St. Lawrence Seaway, the eering Committee for the Ontario Government's Lakeore Capacity Study, an International Joint Commission Research Advisory Board working group (Social Sciences, Economics and Legal Aspects), and as observers at meetings of the U.S. Great Lakes Basin Commission.

Basic and applied research was conducted in the following major program areas:

Economic Baseline Studies

The main thrust in this field has been to carry out research for the two IJC Reference Groups: "Upper Lakes" and "Land Drainage". Specifically, Social Sciences Research is responsible for Canadian co-chairmanship of Working Group A (Upper Lakes Reference Group). This involves collecting background information on the Upper Lakes Basin and its population, and later, a study of the interrelationships between broad geographic characteristics and water quality. To these ends, studies are presently underway to determine population, land use, and economic activities in the Upper Great Lakes Basin. Dynamic modelling techniques are being developed for the integration of the many variables for forecasting developments and effects on pollution levels.

Various studies on the impact of agricultural activities on water quality were undertaken. This resulted in the production of a map showing the distribution of cattle feedlots in the Great Lakes Basin, and in a report analysing the trends in livestock and poultry farming in the basin and their effects on water quality (Figure 49).

As part of the federal-provincial Great Lakes Shore Damage Survey, Social Sciences Research is responsible for the production of an inventory of ownership and uses of properties along the shoreline of the lakes. The great quantities of data resulting from this survey are stored in a computerized data bank.

Much effort has been spent on responsibilities under the Canada-U.S. Agreement, specifically in the preparation and implementation of Tasks B2 and B5 of the Land Drainage Reference Group Study Plan. For the first task, information is being collected concerning the nature and location of specialized land uses in the Basin; for example, liquid and solid waste disposal sites, land fill sites, high-density non-sewered residential areas, etc. The objective of Task B5 is to provide an internally consistent and comprehensive set of forecasts for all sectors and activities of land uses which, directly or indirectly, affect the drainage of pollutants into the Great Lakes. Such socio-economic parameters as population, industrial levels, technological developments and legal frameworks will be considered.

In addition, a study plan for socio-economic research as part of the Limnology Study for Lake Winnipeg has been proposed. The mutual relationship between man and the lake will be explored. This will include a study of present and future populations, industrial impact, production shifts, recreation habits, etc. Lake Winnipeg is especially important since its Basin covers more than 40,000 square miles and is affected by all five Canadian Prairie metropolitan centres and virtually all Canadian Prairie agriculture.

Economic Impact Studies

Under this program, the economic impact of the management of waste heat discharges is being studied. The effects upon the economic system of price increases associated with controlling waste heat discharges will be investigated.

Environmental Contaminants

Research on the uses in the economy of various toxic substances was continued. Papers on Selenium, Cadmium, Beryllium, and Antimony were edited, while a similar paper on Lead has reached the draft stage. Data collection for a document on Phthalates has begun. These papers provide background information for a natural sciences research and control program, and later, for an analysis of the social costs of toxic substances in the Canadian economy. Such factors as incidence of diseases, therapeutic expenditures and loss of livelihood play important roles in the balance of costs and benefits. Most of the effort during this period went into the development of analytical techniques for this study.

Perception and Attitude Studies

A study is now underway, in co-operation with the International Joint Commission, to evaluate the public hearing process as used by the IJC. This is part of a larger study of public participation in water resources management.

A review and evaluation of the use of attitude studies in environmental management was completed. Tentative hypotheses were developed concerning attitude formation on water resource issues.

The attitudes of municipal officials towards the use of renovated waste water and other alternatives to conventional waste treatment were surveyed, and a report on the findings is being prepared.

Legislative and Institutional Studies

A comparative study of the administrative and legal framework within which municipal sewage treatment facilities are financed throughout Canada was begun. Interviews have been held with officials across the country, and relevant policies and legislation are being examined.

The legal and administrative processes governing the location and management of manure disposal sites in the Great Lakes Basin were surveyed.

The legal basis for potential public participation in the management of Canada's water resource is being analysed, particularly in relation to the provisions in the Canada Water Act.

Dynamic Modelling

Acquisition of a computer terminal has resulted in a greater opportunity to use more sophisticated techniques of analysis, specifically the application of dynamic modelling techniques, and quantitative analyses. Through the terminal, various data banks and program packages can be used; for example, DYNAMO, a software package for the building of dynamic models; SPSS (Statistical Package for the Social Sciences) and other programs on file with York University's Institute for Behavioural Research (includi the Institute's Data Bank); and DATA BANK a MASSAGER, the program packages for economic analys The basic software for the CANDIDE (Canadian Disaggre ted Interdepartmental Econometric) model of the Canadi economy has been acquired.

Work was also begun on a mathematical model of t economics of alternate means of phosphate load reducti Some preliminary tests of this model for the OECD w conducted, using data from the Great Lakes.

CCIW Lecture Series

The seminar series for the Centre has been revised, a Social Sciences Research is now organizing a series of f or six major lectures per year. The objective is to provi the scientific staff at CCIW, at neighbouring universities a research institutes, and in other government agencies southern Ontario with a series of lectures focussing unifying principles in multi-disciplinary environmen research. The lectures deal with common backgroun assumptions, analogies in systems, and directions of p losophies and policies as the determinants of environme management. They will be held approximately every weeks and well-known speakers have been invited participate. The first lecture, entitled "Climatic Chan Prospects for Man", was given by Dr. Kenneth Hare.

Information Systems

Access to several computerized information syst was acquired during this year. The most useful of thes WATDOC (Water Resources Data Systems Document F erence Centre), which includes data bases in the fields law, pollution, and environment, as well as a news clippi service dealing with all matters in Canadian newspap pertaining to water (Figure 50). Preparations have b completed for access to a number of major Ameri scientific literature data bases, so that, early in 19

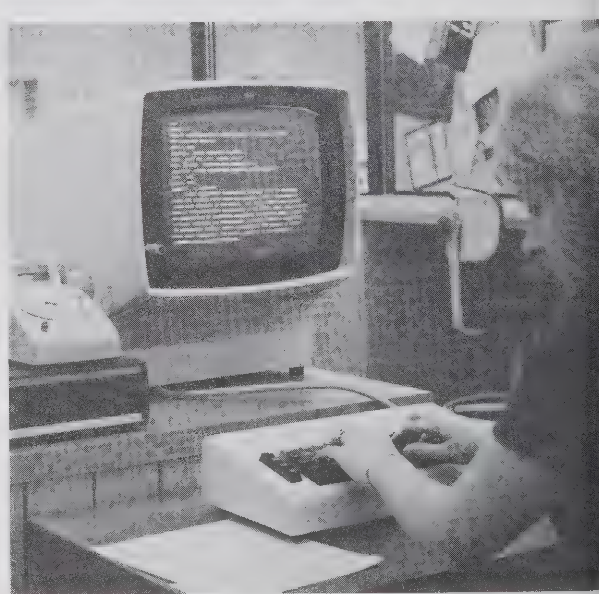


Figure 50. WATDOC information retrieval system in operati

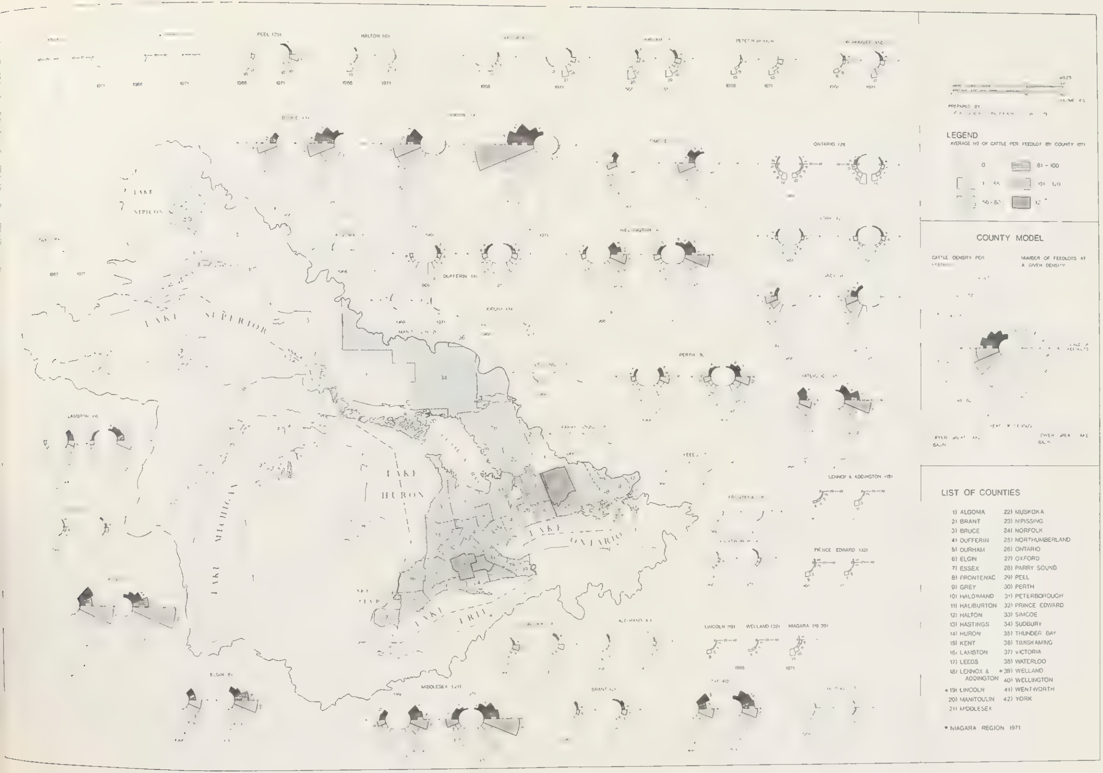


Figure 49. Distribution and concentration of cattle feedlots in the Great Lakes Basin of Canada.

entists have access to more than two million recent ılti-disciplinary literature references through terminals at :IW. Negotiations with the U.S. Department of the terior have led to the formulation of an exchange reement covering references to water research literature. ıother important development is the use of CANSIM anadian Socio-Economic Information Management System). This Statistics Canada Data Base is one of the largest data banks in North America.

Social Sciences Research also provides one of Environment Canada's representatives on the National Library/ Treasury Board Committee for Application Centres for Scientific Information, a group of various government departments interested in computerized documentation.

WATER QUALITY BRANCH

NALYTICAL METHODS RESEARCH SUBDIVISION

The objective of the Analytical Methods Research bdivision (AMR) is to develop or improve analytical thods for the identification and measurement of chemI and biological pollutants in inland waters.

The analytical research is initiated in response to a ted need by:

1. any of the IWD regional water quality laboratories;
2. any division of the CCIW;
3. a national or international committee in which the Department of the Environment is cooperating.

In addition, the AMR scientists may propose and tiate any approved analytical research project that would der analysis more accurate, faster or less expensive, end the detection limit or broaden the present knowge of water pollutants.

Analytical research requests must be clearly defined as the objectives and relevance. On the basis of such initions, the AMR staff provides an estimate of the ation of the project in man/years.

1R Groups

There are presently five teams in the AMR subdivision cializing in the areas of automation of analysis, atomic orption spectroscopy, electro-chemistry (selective-ion :trodes, polarography, potentiometry), gas chromaraphy, mass spectrometry and high-speed liquid chromaraphy. Presently in formation is another team to handle development of analytical methods for biological lutants.

lications

During the year the AMR staff was involved in 24 arch projects. The completed work resulted in 10 lications and 12 scientific presentations at national and rnational conferences.

Among the publications are: (See publications list for references).

'etermination of Submicrogram Levels of Phenols in /ater, by P. D. Goulden and P. Brooksbank.

The method comprises an automated distillation step owed by colour development with either 4-Aminoipyrine (4AAP) or 3-Methyl-2-benzothiazolinone hydrae (MBTH) at a rate of 10 samples per hour with a it of detection of 0.2 milligrams per litre.

— Automated Solvent Extraction for the Determination of Trace Metals in Water by Atomic Absorption Spectrophotometry, by P. D. Goulden, P. Brooksbank and J. F. Ryan.

The method described in this paper is a solvent extraction method, completely automated, capable of handling 40 samples/hr with a detection limit of 0.5 ug/l. It is based on complexing the metal with ammonium pyrrolidine dithiocarbamate (APDC) and the subsequent quantitative extraction of the complex with methyl isobutyl ketone (MIBK). The MIBK phase is then separated and aspirated into the flame of an atomic absorption spectrophotometer.

— Automation of Direct Potentiometry, by I. Sekerka and J. F. Lechner.

The paper discusses the application of ion selective electrodes for the simultaneous automated measurements of fluorides and ammonia at a rate of 20 samples per hour.

— Potentiometric Determination of Nitrilotriacetate in Water and Sewage by I. Sekerka, J. F. Lechner and B. K. Afghan.

The method is based on potentiometric titration of separate aliquots of sample solution with thallium (III) and cupric ions using platinum redox electrode and calculating the NTA contents from the difference of the two titrants consumed. The double titration is required by the fact that T1 (III) forms a 2:1 ratio complex with NTA and 1:1 complexes with other chelating agents such as EDTA, CDTA, EGTA, etc. Cupric ion forms 1:1 complexes with all tested chelates. The advantage of the new procedure over the existing polarographic procedure is that it allows on-site measurements by means of simple electrode titration and thus eliminates the need of taking samples to the laboratory with the inherent sample preservation problems.

— Analytical Research at the Canada Centre for Inland Waters, by S. Barabas.

The article provides information on the scope, objectives and means of the Analytical Methods Research Subdivision within the broader context of the Inland Waters' water quality objectives.

— An Improved Method for the Determination of Trace Quantities of Phenols in Natural Waters, by B. K. Afghan,

P. E. Belliveau, R. H. Larose and J. F. Ryan.

The procedure uses solvent extraction in place of distillation to concentrate and separate phenols from interferences. The preconcentration of phenols is effected by extraction into n-butyl acetate or iso-amyl acetate and the final readout is by either spectrophotometry (with 4-aminoantipyrine), differential UV absorption or molecular fluorescence depending on the requirements of the analysis as to the sensitivity and the phenol differentiation.

– Confirmation of Lindane Identity in Environmental Samples Using Gas/Liquid Chromatography and High Speed Liquid Chromatography, by R. H. Larose.

The determination of lindane in environmental samples is usually performed by gas-liquid-chromatography. Unfortunately, this method is not too accurate, especially in the case of animal samples such as fish, where fatty substances cause much interference. A method has been developed which permits removal of all coextractives from lindane using high speed liquid chromatography. Fractions are collected from the liquid chromatograph for further analysis by gas chromatography. The procedure takes less than five minutes and recoveries of more than 90% are obtained. The detection limit for water samples is 5 ug/l.

– Automated Determination of Arsenic, Antimony and Selenium in Natural Waters, by P. D. Goulden and P. Brooksbank.

A method is described for the determination of sub-microgram levels of antimony, arsenic and selenium in natural waters. Stibine, arsine and hydrogen selenide are produced from the samples in an automated system and passed to a tube furnace mounted in the light path of an atomic absorption spectrophotometer. The use of a tube furnace as a covalent hydride decomposition device gives an increase in sensitivity over a conventional hydrogen-argon entrained air flame of at least two orders of magnitude. The method will allow the analysis of 40 samples an hour with a limit of detection of 0.1 ug/l for arsenic and selenium and 0.5 ug/l for antimony. With a dual-channel spectrophotometer simultaneous determinations of As and Se levels have been made on a large number of natural water samples.

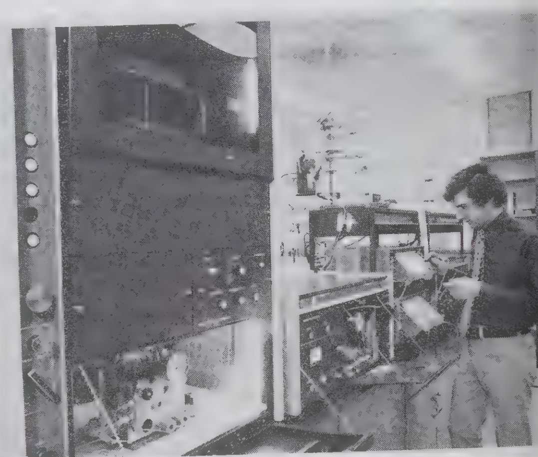
– Automated Phosphate Analysis in the Presence of Arsenate, by P. D. Goulden and P. Brooksbank.

The arsenate interference in the determination of phosphate in natural waters is eliminated by reduction with thiosulfate to arsenite in an acidic medium prior to the addition of the molybdate reagent.

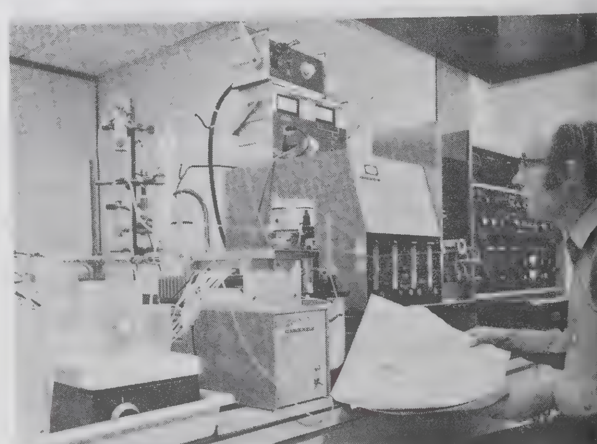
– Automated Determination of Fluoride Ion in the Parts per Milliard Range by I. Sekerka and J.F. Lechner.

The method allows the detection of as little as 2 parts per billion fluoride with a relative standard deviation of less than 2% and the recovery in the range of 96-107%.

Mike Comba (foreground) and Dr. Frank Onuska check the settin of their Mass Spec/Gas Chromatograph for the identification pesticide residues.



Dr. Aaron Wolkoff identifies the peaks of some 20 phe compounds by high-speed liquid chromatography.



Dr. Peter Goulden observes the flow rates in the simultan analysis of selenium and arsenic by atomic absorption spectros

her Projects Completed in 1973

Determination of Citric Acid in Water and Sewage Samples, by B. K. Afghan and J. F. Ryan.

Simultaneous Determination of Na^+, K^+ and NH_4^+, by Automated Direct Potentiometry, by I. Sekerka and J. F. Lechner.

Potential Interferences in the Determination of Soluble Iron in Natural Water with TPTZ, by P. D. Goulden, P. D. Bothwell and J. P. Emery.

Combustion of Covalent Hydrides in a Tube Furnace, by P. D. Goulden and P. Brooksbank.

Determination of Nanogram Quantities of Formaldehyde by Twin-Cell Polarography, by B. K. Afghan and J. F. Ryan.

Automated Simultaneous Determination of Water Hardness, Conductivity and pH, by I. Sekerka and J. F. Lechner.

Organochlorine Pesticide Photoalteration Products and Their Identification by Means of Gas Chromatography, Mass Spectrometry and Nuclear Magnetic Resonance, by F. I. Onuska and M. Comba.

rk in Progress

Differenciation and Measurements of Phenols by Reverse-Phase High Speed Liquid Chromatography (A. W. Wolkoff and R. H. Larose).

A Rapid Method for Chlorophyll Analysis (P. D. Goulden and P. Brooksbank).

Determination of Copper, Lead, Zinc and Cadmium in Natural Waters by Twin-Cell Polarography (B. K. Afghan and J. F. Ryan).

Determination of Dissolved Organic Carbon (DOC) in the Parts-per-Billion Range (P. D. Goulden and P. Brooksbank).

Determination of Total Sulfur and Total Sulfides (I. Sekerka and J. F. Lechner).

Mass Spectrometric Characterization of 14-oxathiins (F. I. Onuska and M. Comba).

Determination of Hydrocarbons in Water by High-Speed Liquid Chromatography (A. W. Wolkoff and R. H. Larose).

ATER AND WASTEWATER TREATMENT RESEARCH

The Water and Wastewater Treatment Research Sub-ision generates scientific information that can be used to ntrol and manage the quality of Canada's water re-urces. To meet its responsibilities, the subdivision under-es studies in the Canada Centre for Inland Waters, oratories and, in addition, initiates, administers and ordinates a number of studies conducted within the nsulting and university scientific communities. Some odivision activities are initiated from within. Others are dertaken on request, and some are assigned to the sub-ision as part of the federal government's commitment to pport specific water quality control research under both e Canada-U.S. and Canada-Ontario Agreements.

Development of Improved Reverse Osmosis Membranes (H.K. Johnston)

Static and dynamic reverse osmosis membrane test cells were designed within the subdivision and manufactured at the Canada Centre for Inland Waters. Dynamic systems of 6 cells each are currently in operation. These cells employ both series and parallel flow patterns. Membrane casting facilities were designed and manufactured permitting careful control of all casting parameters. Cellulose acetate reverse osmosis membranes, which exceed the performance of commercially available products, are prepared within subdivision facilities.

Studies on viscometric behaviour of concentrated cellulose acetate solutions have led to a theory which allows *a priori* production of casting dope formulations to prepare efficient reverse osmosis membranes. These new concepts might permit similar development of other cellulosic derivatives.

Development of Reverse Osmosis Membranes Capable of Withstanding Extremes in pH Without Undergoing Hydrolysis (H.K. Johnston)

The top and/or bottom sides of cellulose acetate membranes are being treated both before and after shrinkage. The basic approach is to chemically modify the membrane surfaces, thereby giving greater chemical resistivity while increasing the thickness of the bound water layer through a reduction in the wetting angle. Methods being studied include:

Irradiation from a Co^{60} γ cell to produce surface-free radicals for copolymerization, γ radiation induced in situ copolymerizations, ozone, and ultraviolet irradiation at different wavelengths, both in the presence and absence of different oxidizing chemicals such as chlorine.

The Application of Reverse Osmosis Membranes to the Improvement of Industrial Waste Effluents (H.K. Johnston)

The quantitative removal of thirteen different heavy metals by reverse osmosis has been studied by the use of static cells. Correlation of the separations with the basic physico-chemical characteristics of the different metals is underway. A vapor phase membrane copolymerization cell has been designed and constructed. This cell will be used to produce high-flux membranes with extended lifetimes through their ability to operate efficiently while exhibiting little pressure-induced compaction.

Treatment of Waste Treatment Plant Effluents by Reverse Osmosis - Canada-Ontario Agreement (H.K. Johnston)

A complete research pilot plant has been designed and assembled to permit an evaluation of on-site reverse osmosis efficiency under a variety of controllable operating conditions. The design has been based on a modular concept to permit easy assembly/disassembly and modification. The entire laboratory is mounted in a self-contained 18-foot trailer. Laboratory tests have been carried out using static and dynamic test systems to evaluate the efficiency of removal of a variety of nitrogen and phosphorus containing materials under various conditions of pH and concentra-

tion. Parallel laboratory and pilot plant investigations will include studies on the removal efficiencies of P, N, $FeCl_3$,Al_2SO_4, $CaCO_3$, B.O.D.$_5$, C.O.D., T.S., T.O.C., T.C., colour and coliforms.

The Removal and Destruction of Polychlorinate Biphenyls (PCB's) (J. Lawrence)

Methods of separating from water PCB's and ultimately destroying them are being studied within subdivision laboratories. The absorption of PCB's onto activated carbon, polyurethane foams and other suitable media is one of the removal methods being studied. PCB destruction methods being considered are: (a) radiation - sunlight and lasers; (b) high temperature incineration; (c) anodic oxidation and (d) ozonation.

The Removal of Asbestos Fibres from Contaminated Water Sources (J. Lawrence)

This project aims to develop a method for substantially reducing the numbers of chrysotile and cummingtonite fibres in municipal water supplies. The study has been undertaken because of growing concern about the possibility that asbestos fibres may, in high concentration, cause a health hazard. Fibres in various water samples are being treated then counted under an electron microscope.

Removal of Trace Metals from Wastewater by Zeolite (A. Netzer)

Experiments were undertaken to determine removal rates of aluminum, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc from aqueous solutions. All the zeolite studies were conducted within the pH range 3-11. Removal rates greater than 99.5% were observed.

Removal of Trace Metals from Wastewater by Lime and Ozonation (A. Netzer)

Experimental studies showed that ozone treatment, followed by precipitation, will remove from aqueous solutions trace metals as hydroxides or oxides. Solutions containing aluminum, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver and zinc were studied. Removal rates greater than 99.5% were observed.

To explore the feasibility of applying lime and ozonation treatment on a large scale, a pilot study was undertaken. Results permitted the establishment of general guidelines for determining optimum operating values of various process parameters. They also indicated that removal of trace metals from wastewater by lime and ozonation is feasible.

Removal of Trace Metals from Wastewater using Discarded Automotive Tires (A. Netzer)

The use of worn and discarded automobile tires to remove trace metals from wastewaters was investigated. Experiments indicate that shredded rubber tires will remove trace metals from aqueous solutions by reaction with the sulfur in the rubber. Solutions containing aluminum, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver and zinc, were investigated. Removal rates greater than 99.5% were observed.

Removal of Trace Metals from Wastewater by Adsorptio[n] on Sand (A. Netzer)

Experiments to determine the merit of using sand t[o] remove trace metals from water and wastewater wer[e] undertaken.

Removal rates from solutions of aluminum, cadmiu[m], chromium, cobalt, copper, iron, lead, manganese, mercur[y], nickel, silver and zinc from aqueous solutions b[y] adsorption were studied within the pH range 3-11. Result[s] have been obtained in terms of initial concentration an[d] pH.

Removal of Trace Metals from Wastewater by Adsorptio[n] on Activated Alumina (A. Netzer)

Removal of aluminum, cadmium, chromium, cobal[t], copper iron, lead, manganese, mercury, nickel, silver an[d] zinc solutions using activated alumina as an adsorbent wa[s] investigated over the range of pH 3-11. Removal rates i[n] excess of 99.5% were observed.

Research into Novel Vessel Waste Treatment Systems [-] Canada-U.S. Agreement (A. Netzer)

Experiments were conducted to evaluate possible nove[l] physical-chemical methods treating marine sewage on boar[d] ships. Coagulation with various inorganic chemicals alon[g] with polymeric flocculant aids and adsorption on t[o] powdered or granular activated carbon were investigate[d]. The effect of aeration on the system was also studied.

Results indicate that reductions of B.O.D., T.O.C. an[d] suspended solids in excess of 80% can be attained with th[e] proper dose of activated carbon, coagulant and flocculan[t]. Further studies indicate that subsequent convention[al] disinfection by chlorine or ozone can reduce bacteri[a] counts to acceptable levels, prior to discharge.

The processes studied are economically attractive an[d] highly efficient. Preliminary economic analysis indicate[d] low capital investment and minimum operating costs. I[n] addition, it appears that the processes can be scaled to mee[t] most requirements, are resistant to shock loads, ar[e] independent of ambient temperature, require little spac[e] and can be fully automated.

Treatment of Combined Sewer Overflows - Canada-U.S[.] Agreement (A. Netzer)

A comprehensive study of a high-rate wastewate[r] treatment concept for abatement of pollution from com[-]bined sewer overflows (C.S.O.) is being carried out unde[r] contract by several consultants. This project is co-ordinate[d] by the Water and Wastewater Treatment Research Sub[-]division. Two pilot plants have been constructed. The firs[t] pilot plant is based on air floatation and hydrocyclones while the second includes microscreen and ozonation. Th[e] objective of these pilot plants is to determine the size of th[e] various equipment and the major operation parameters.

Oxy-Chlorination of Organic Pollutants - Contract (A[.] Netzer)

A study to determine the products formed durin[g]

ypochlorous acid treatment of organic compounds (such s phenols and aromatic compounds which often pollute vater supplies) is being conducted at the University of Vaterloo under a research contract administered and o-ordinated by the Water and Wastewater Treatment Research Subdivision. The study is designed to establish vhether highly chlorinated products of potential biological oxicity can arise under the conditions employed in the hlorination and superchlorination of municipal water upplies, sewage effluents and industrial waters.

The study has been initiated in response to concern bout the possibility of hydrocarbon pollutants, (e.g., Bunker C and other types of fuel oils) forming polyhlorinated aromatic hydrocarbons such as polychlorinated iphenyls, as a result of chlorination.

The organic compounds being examined are those ound as contaminants of water supplies. The study ncludes product identification and synthesis.

ron and Manganese Removal from Rural Water Supplies - Contract (A. Netzer)

A contract, undertaken by James F. MacLaren Limied, to study removal of iron and manganese from small ural water supplies is being co-ordinated by the subivision. The objects of this study are: to evaluate new and romising processes; to assess real capabilities by field trials; o examine and evaluate existing municipal facilities and to can commercial-industrial facilities for useful ideas.

Two ozone-filtration systems have been installed; one in New Brunswick, the other in Ontario. Samples are collected and analyzed at the Canada Centre for Inland Waters. The cartridge-type filter is constructed of greensand.

Induced Biodegradability by Laser Irradiation (B.G. Oliver)

The purpose of this project is to investigate the feasibility of using high intensity light from lasers to convert materials which are resistant to biological degradation to biodegradable forms. Photoalterations of organic molecules have been observed using ultraviolet light from a laser and a mercury arc lamp. Present studies are focussed on classifying the organic molecules which can be degraded with light, those which exhibit an increased rate of breakdown at higher light intensities, and those which will decompose under the influence of light when photosensitizers are added to the system.

Heavy Metal Concentration Points in Conventional Activated Sludge Waste Treatment Plants (B.G. Oliver)

This project is complete. The conclusions are that much of the heavy metal entering activated sludge treatment plants is removed by the process and is concentrated in the sludge. There is concern about the fate of heavy metals in treatment plants that receive some industrial wastewaters. This is because the resulting sludges are sometimes disposed of on crop-growing soil and heavy metals might be concentrated by either crops or animals that consume the crops. (See EPS effort).

nland Waters Directorate—Ontario Region

WATER PLANNING AND MANAGEMENT BRANCH

In September, the Inland Waters Directorate estabished a Toronto Liaison Office to ensure even closer vorking relationships with Ontario colleagues and other ederal departments with regional headquarters in Toronto. Office space was made available by the Ministry of the Environment at 135 St. Clair Avenue West and is shared vith the Regional Office of the Environmental Protection ervice.

The Head of the Inland Waters Directorate, Toronto Office, is Mr. Derek M. Foulds, who is also in charge of Water Planning and Management activities in Ontario. These ctivities include the Great Lakes-St. Lawrence Study Office in Cornwall directed by Mr. D.F. Witherspoon; the engineering staff directed by Mr. W.P. Persoage at Burlington; and a sub-office in Niagara Falls which was transferred to the Branch from the Water Survey of Canada in November.

The Branch carries out extensive studies related to water management problems in Ontario and is responsible for providing support to the International Joint Commission in various operational activities governing the control of the levels and outflows of the Great Lakes. Its members serve in various capacities on several Engineering Boards and Boards of Control established by the Commission, and also on a number of joint Canada-United States International Committees.

Great Lakes - Levels and Flows

Record high lake levels occurred on some of the Great Lakes during 1973 as a result of extremely high water supplies which greatly exceeded those associated with the previous record levels of 1952. In the unregulated lakes, St. Clair and Erie exceeded previously recorded maximum levels by as much as 9 inches, and lake Michigan-Huron reached the highest level since 1886. In the regulated Lakes, Superior levels approached but did not exceed the prescribed maximum; Ontario did exceed the prescribed maximum by about 15 inches but did not surpass the 1952 record.

Extraordinary action was taken to alleviate high water level conditions on the lower lakes. In response to an application from the United States Government and expressions of concern by the Government of Canada, the International Joint Commission directed its Lake Superior Board of Control to deviate from the existing regulation plan. Accordingly, Lake Superior outflows were regulated to provide relief from critical high water levels downstream without causing undue detriment to Lake Superior interests. In spite of this action, high Superior outflows combined with very high Lake Huron levels, caused problems in the St. Marys River.

Lake Ontario supplies averaged one million gallons per minute more than in the previous record year (1952) and without regulation the lake would have exceeded the previous record level by 15 inches. The Ontario outflows exceeded the previous maximum by about 10% in the period following the spring flood on the Ottawa River. By the end of the year, lake levels were close to average. The St. Lawrence River Board of Control has requested studies on how regulation may be improved.

Considerable time was spent responding to public inquiries on lake levels, making presentations to shoreline and water use groups and giving interviews to radio, TV and newspaper representatives on the subject of high lake levels. To assist in this activity, forecasts of the possible range of Great Lakes and Montreal Harbour levels for the ensuing six months were prepared every month and incorporated into a news release which accompanies the monthly publication of the Marine Sciences Directorate.

Branch members participated during the year in the International Great Lakes Levels Board study of the feasibility of further regulating the levels of the Great Lakes. Through a considerable effort, the final report to the International Joint Commission was completed in December. Seven Appendices to the report are in the final stages of preparation and should be completed by May, 1974.

On the Niagara River, Branch representatives participated in several water use studies for the Commission's International Niagara Board of Control and the International Niagara Committee which was established by the Governments of Canada and the United States to determine the amounts of water available for purposes of the Niagara Treaty of 1950. Included were hydraulic studies of the effects of the temporary closure of the Welland Canal during the 1972-1973 winter season and of placement of earth fill in the Upper Niagara River at Fort Erie. A rela study, currently in progress, involves the degree, if any, which water level variations in the Chippawa Grass Isla Pool above the Falls could influence flow out of Lake E Results of the last two studies may influence the La Levels Board's conclusions. The Board is currently study the effects of allegations of environmental effects related the use of an ice boom which is installed at the outlet Lake Erie every winter season.

Branch representatives are currently engaged in investigation of possible measures which may be desira or necessary to preserve or enhance the beauty of American Falls at Niagara. The study is being carried for the I.J.C. by the American Falls International Board. June, a panel of experts in landscape architecture a aesthetics discussed alternatives and related problems a seminar in Niagara Falls, Ontario. A brochure on subject was prepared and more than 100,000 copies w distributed to the public. At year-end, a first draft of final report was completed for consideration by the Boa

Great Lakes - Erosion and Flooding

Serious flooding and erosion problems occurred certain areas of the lower lakes. As a result, the Gove ments of Canada and Ontario embarked on an intens study of the affected shorelines including aerial ph ography and mapping of the eroded shorelines, the de mination of erosion rates, an inventory of property val and a survey of the damages which resulted. The Wa Planning and Management Branch provided a representa on the federal-provincial steering committee for the proj and a project engineer who headed the stage-damage fi survey operations which were completed in Decemb 1973.

A federal interdepartmental task force, chaired by Director, Canada Centre for Inland Waters, Burlington, created to review all available information on shore eros in the Great Lakes-St. Lawrence system to aid in development of federal policy on shoreline managem With the assistance of representatives from the Ministry Transport, Department of Public Works, and Lands Di torate of Environment Canada, D. W. Brown of Wa Planning and Management Branch prepared a report wh compiles and analyses all current information on problem.

The Branch is active in:

1. The preparation of a report by a Working Gro involved in the study of Water Quality in the Up Great Lakes;
2. Producing forecasts of water surface temperat in the Lake Ontario to Montreal reach of the Lawrence River relating to scheduling the end navigation and the installation of ice booms;
3. Estimation of heat losses in the South Shore Ca for the St. Lawrence Seaway Authority; and
4. The preparation of guidelines in conjunction w other services for environmental studies by pro nents of federal projects, such as Pickering Airp and Sault Ste. Marie Harbour.

WATER QUALITY LABORATORY AND NETWORK

The role of the Water Quality Laboratory and Network ıtario Region) is (1) to operate a water quality network the Ontario Region and (2) to operate an analytical mistry laboratory to support regional and national water ıagement programmes.

In addition to the Analytical Services Section and the ɛcial Services Section which were already in existence, Water Quality Branch (Ontario Region) now includes a nitoring and Surveys Section to undertake field prommes.

alytical Services Section

This section consists of a Ships Support Laboratory, an rganic Analysis Laboratory and an Organic Analysis ɔoratory. During the year these laboratories performed re than 200,000 tests on more than 25,000 samples porting 72 different projects in cooperation with various eral and provincial governments, universities and other ncies.

Some of the major projects supported are listed below.

Great Lakes Monitor Programme

The Section participated in 21 cruises, including six on ⟨e Superior, two on Lake Huron, eight on Lake Ontario I five on Lake Erie. Some 78,400 tests were conducted, ut 48,100 of which were done on board ship, on 7,300 ter and suspended particle samples taken during these ises. The Technicon AutoAnalyzer equipment on board ɔ was replaced by the improved AutoAnalyzer II tems, which performed well throughout the year.

Water Quality Monitoring and Survey Programme

The Section continued to support the Water Quality nch monitoring and survey programmes in Ontario and ebec. A total of 596 water samples from Ontario and ebec were received and analyzed during the year.

St. Lawrence and St. Marys River Studies

These studies were supported by the analysis of 424 ıples collected by the Monitoring and Surveys Section. ne 2,700 tests were conducted in field laboratories and ıples were brought back to the laboratory for further lysis.

NTA Programme

This programme involves analysis of municipal water ply samples taken from selected sites across Canada, as l as continued analysis of samples from Hamilton bour, Lake Ontario, groundwaters in Manitoba and tern Ontario, and marine waters from Vancouver and ifax Harbour.

Other Projects

The section also supported such studies as the Point ırce Study in Marathon, Ontario, carried out by the eat Lakes Biolimnology Laboratory and Lakes Research Division, the Precipitation Chemistry Programme carried out by the Monitoring and Surveys Section, and many other projects being carried out by scientists at CCIW and elsewhere.

(6) Quality Control

The internal quality control programme was extended during the year so that now approximately 15-20% of all analyses are done for quality control purposes. In addition, the section participated in the quality control programmes operated by the Special Services Section and supported those programmes by analysis of samples for certain storage and other tests.

The section participated in several split sample programmes, including separate split sample projects with the Ontario Ministry of the Environment, the Environmental Research Associates Division of Korab Marine Limited, and with Procter and Gamble (the latter with regard to NTA). Also, the Organic Analysis Laboratory was involved with the Fisheries Inspection Branch and the Guelph Pesticide Residue Laboratories in the analysis of a number of fish check samples for PCBs and chlorinated hydrocarbon pesticides.

Special Services Section

The Special Services Section plays a national role in the overall coordination of activities of the four regional Water Quality laboratories. These include (1) maintaining and updating the analytical manual, (2) method development as requested by the regional laboratories, (3) operation of the quality control programme, and (4) other assistance and advice to the regional laboratories regarding analytical procedures.

The objective of the Quality Control programme is to help ensure the continuation of a high standard of analytical quality among the regional laboratories and other laboratories which have contributed data to NAQUADAT and to other programmes of interest to the Inland Waters Directorate. There are currently 40 participants, including 13 federal, 14 provincial and two municipal government laboratories as well as two universities and nine private companies.

The quality control functions include the National Quality Control Programme which last year undertook laboratory intercomparison studies of major ions, physical properties, pesticides and trace metals among the 40 participants; an Inter-Regional Quality Control Programme in which natural samples are distributed once a month to the four WQB regional laboratories (Vancouver, Calgary, Burlington, Moncton) for a full analysis; and guidance and analysis of data with regard to the various split sample exchanges carried out between the Analytical Services Section and other laboratories.

The method development section carries out the evaluation and development of analytical methods to recommend the best method and instruments for new tests

Table 11. St. Lawrence River Data Summary–1973*

PARAMETER	MAY	JULY	SEPTEMBER
TOTAL PHOSPHORUS mg/1-P	.020	.020	.019
TOTAL SOLUBLE NITROGEN mg/1-N		.28	.29
NITRATE + NITRITE mg/1-N	.124	.062	.052
CHLORIDE mg/1	24.6	27.0	26.5
IRON, EXTRACTABLE mg/1	.075	.047	
DISSOLVED OXYGEN mg/1	11.9	8.2	8.7
pH	8.2	8.0	8.2
FECAL COLIFORM MF/100 ml	3	3	3
FECAL STREPTOCOCCUS MF/100 ml	2	2	3
HETEROTROPHS Standard Plate Count 7 day 20°C	3380	2350	2050

*Means of 69 stations

which will be carried out by the regional laboratories. functions as a service to the regional laboratories a undertakes investigations primarily at their request. If method cannot be found that will fulfil a need for t regional laboratories without undertaking a basic resear project, the project is referred to the Analytical Metho Research Subdivision.

During the year, a number of development proje were completed, including:

(1) A GLC method for detecting as little as 0.05 u of coprostanol and cholesterol, which will be us as an indicator of fecal pollution in a number projects.
(2) A simple and sensitive GLC method for detect as little as 0.01 ug/l of pentachlorophenol routine use by the regional laboratories.
(3) A method to analyse 14 organophosphorus pest des in water, which is now in use in the regio laboratories for monitoring run-off waters af forest spraying.
(4) A survey of methods for PCB quantitation select the best available method, which is n being adapted to routine analysis for the automa calculation of PCB levels.
(5) A method to analyse 21 metals in sediments bomb digestion followed by atomic absorpti spectrophotometric analysis.

Table 12. St. Marys River Data Summary - August, 1973*

PARAMETER	AUGUST 27	AUGUST 28	AUGUST 29	AUGUST 30	AUGUST 31
TOTAL PHOSPHORUS mg/1-P	.004	.005	.005	.006	.007
TOTAL SOLUBLE NITROGEN mg/1-N	.40	.38	.42		
NITRATE + NITRITE mg/1-N	.245	.229	.229	.251	.227
CHLORIDE mg/1	1.3	1.0	1.3	1.1	1.0
IRON, EXTRACTABLE mg/1	.024	-	.017	-	.006
DISSOLVED OXYGEN mg/1	9.4	9.4	9.5	9.5	9.4
pH	8.2	8.2	8.2	8.2	8.2
TOTAL COLIFORM MF/100 ml	83	78	124	188	228
FECAL COLIFORM MF/100 ml	5	3	6	13	7
FECAL STREPTOCOCCUS MF/100 ml	2	3	3	10	6
HETEROTROPHS Standard Plate Count 7-day 20°C	1600	2500	2200	2300	2400

*Means of 34 stations

(6) A simple method for confirmation of heptachlor in the presence of PCBs using solid matrix derivation techniques.

nitoring and Surveys Section

The Monitoring and Surveys Section was established ring 1973 with a section head and a senior technician operating three major programmes through most of the year; the Water Quality Surveys Programme, the Precipitation Chemistry Programme and the Water Quality Monitoring Programme. In addition, a Toronto liaison office was established at the offices of the Ontario Ministry of the Environment in Toronto and is regularly visited by Section personnel.

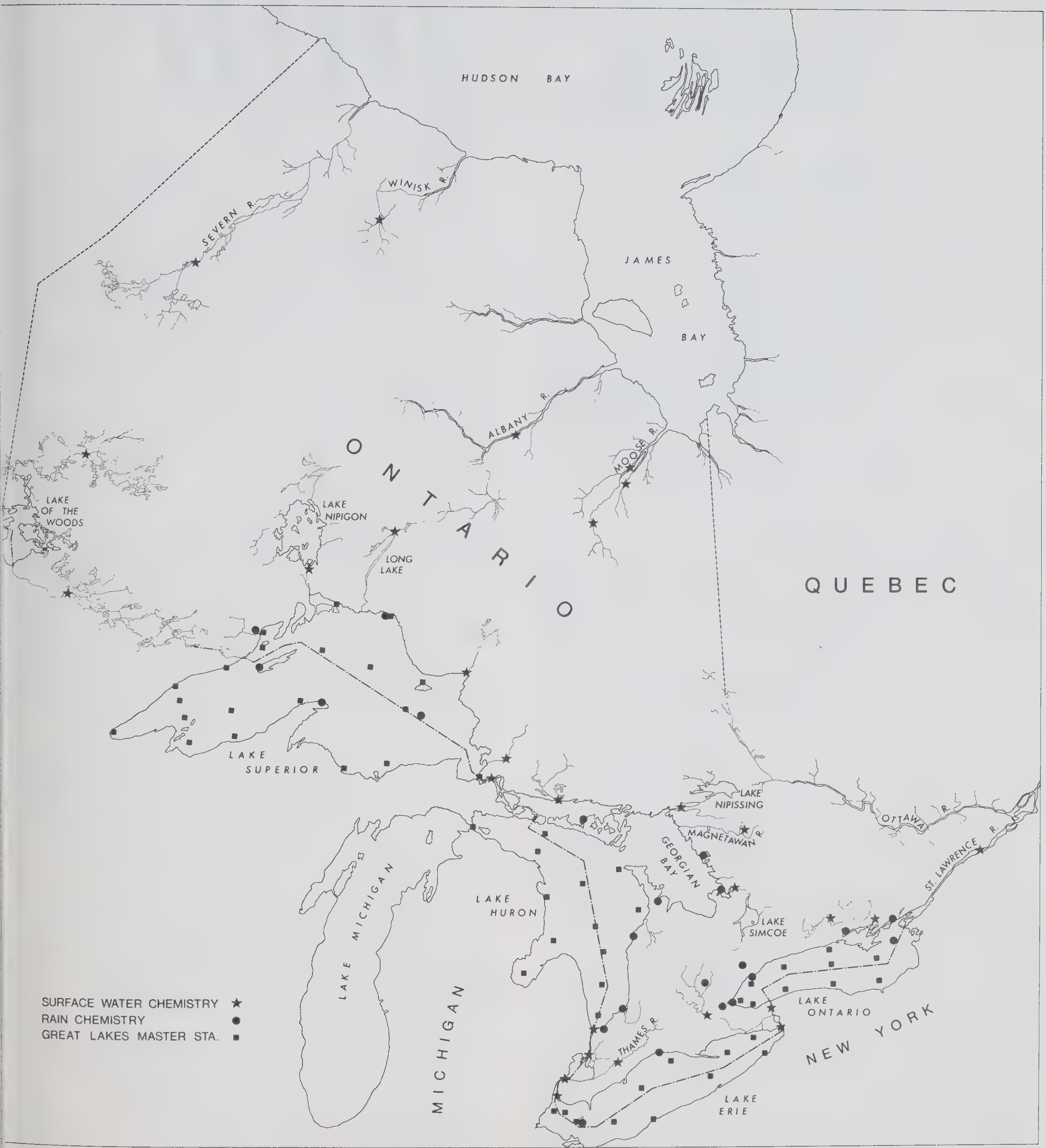


Figure 51. Water Quality Branch Ontario Region network stations.

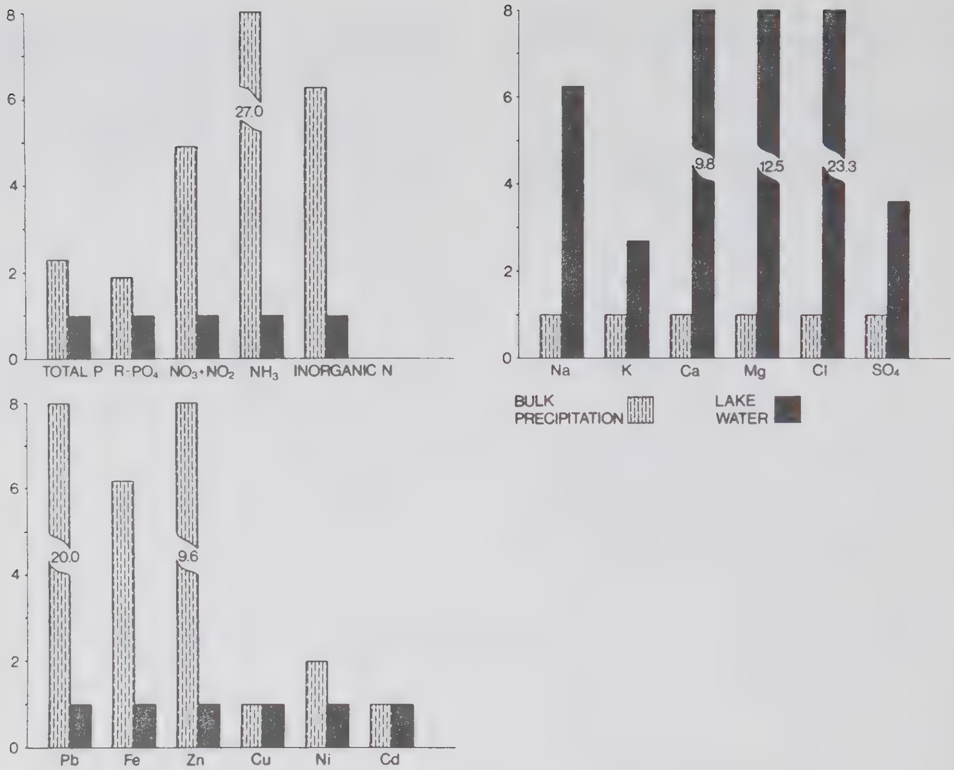


Figure 52. Ratios of concentrations of various constituents in precipitation and in lake water, Lake Ontario Basin.

Water Quality Surveys Programme

This programme involved water quality surveys on the St. Marys River and the St. Lawrence River which were coordinated with surveys carried out by the Ontario Ministry of the Environment, and which were supported by the Analytical Services Section as well as by the Microbiological Unit and the Technical Operations Section of Scientific Operations Division, and by the Marine Sciences Directorate at CCIW.

The objectives of the Water Quality Surveys were to determine the present water quality of the interconnecting channels, to supply historical or baseline data by which future deterioration or improvement can be measured, and to identify any transboundary movement of pollutants. The information will help evaluate the effect of improvements in wastewater treatment facilities provided for in the Canada-U.S. Agreement on Great Lakes Water Quality, 1972.

Three five-day surveys were carried out on the St. Lawrence River during the field season. In each survey a total of 69 stations in 31 ranges were sampled daily. Field laboratories were set up to determine nutrients, pH, dissolved oxygen and conductivity as well as to prepare samples for later bacteriological tests. Table 11 summarizes some data forwarded to the IJC from the project.

Two similar surveys were carried out on the St. Marys River, one in August and one in November. A total of 34 stations in seven ranges were sampled daily in the August survey; the November survey was similar, but had to partly curtailed due to weather conditions. Table summarizes some results from the August survey.

Precipitation Chemistry Programme

Responsibility for the operation of this programme transferred this year from the Lakes Research Division the Monitoring and Surveys Section. The programme now increased to comprise 22 stations in the Great La Basin; the stations are shown on Figure 51. In addition programme of rain collection and analysis was initiated the major survey vessels, the Martin Karlsen and Limnos. Samples taken on the Karlsen are analy immediately for certain parameters, while those taken the Limnos are preserved and analysed later.

During 1973 the emphasis of this programme shifted the Upper Lakes basin in response to the requirements the Upper Lakes Reference Group on the pollut problems of Lake Huron and Lake Superior. Eight r stations were established in these two basins during 19 Most of the samples collected by the two survey ves during 1973 were collected on Lake Superior.

Some of the results of this project are illustrated Figure 52 which shows the relative concentrations o number of constituents in precipitation and in lake wa for the Lake Ontario basin. In this chart the lower of e pair of concentrations is set equal to 1. The chart sh that precipitation accounts for significant inputs

ıtrients and some metals but negligible inputs of major ns.

ater Quality Monitoring

The Water Quality Branch operates a national base line onitoring programme consisting of fixed sampling stations roughout Canada from which samples are regularly taken ıd analysed for a wide variety of constituents. The ogramme is designed to assess the quality of lakes and ⁄ers and to determine trends in water quality. There are about 600 sampling stations in the national programme with the Water Quality Laboratory and Network (Ontario Region) responsible for the operation of the stations located in Ontario.

As shown in Figure 51, there are presently 104 stations in the Ontario Region, of which 22 are precipitation stations. Of the remaining 82 stations, 28 are river samples collected by the Water Survey of Canada or by lay collectors and the rest are on the Great Lakes and are sampled from survey vessels.

WATER SURVEY OF CANADA

The Ontario Region of the Water Survey of Canada is imarily responsible for the inventory of water quality of e Water Resources in Ontario. The District Office is cated at Guelph, with sub-offices at Ottawa, North Bay, agara Falls and Sault Ste. Marie. District operations from e Niagara Falls Office were transferred to Guelph during e year, and Mr. V. J. M. Johns was transferred to the ater Planning and Management Branch.

Operations of the network in the western and north-astern part of the Province are presently carried out by e Manitoba District of the Western Region, Inland Waters rectorate. In addition to the water quality planning and onitoring programmes, the Ontario Region, in co-eration with the United States Corps of Engineers, are sponsible for monitoring programmes on interconnecting annels in the Great Lakes and specifically in the Niagara ver where considerable work is done for the International agara Board of Control.

Operation and maintenance of water level stations on e Great Lakes is carried out for the Marine Sciences rectorate, and a limited sampling programme is also rried out for the Water Quality Branch.

A review of the functions of the various sections in the ntario Region is as follows:

eld Operation Section

This section has three prime work areas:

1) Hydrometric Gauging Stations.
2) Great Lakes Water Levels.
3) Sediment Surveys.

A *Hydrometric Network* of approximately 370 active uging stations was operated in 1973. An extensive field ogramme of collecting discharge measurements to de-rmine or verify water level-discharge relationships was rried out. This included a total of approximately 3,000 easurements and 16 new gauging installations. Water level ta extraction from the recorder charts was made with the Mac Pencil Follower and data was processed on the 3.M. 370-55 computer at the University of Guelph omputer Centre. Sampling programmes on behalf of the ater Quality and Groundwater Divisions were also com-eted. One hundred and sixty-three water quality samples d six groundwater discharge measurements were collected and forwarded to the respective group involved.

A total of *41 Water Level Stations* located on the *Great Lakes* and St. Lawrence River were maintained for the Tides and Water Levels Section, Marine Sciences Directorate, Ottawa. A Telex Data Retrieval system is now installed and operating at at least one location on each of the Great Lakes. Three Tele-Announcing systems were installed at other existing stations during the year.

A complete *Sediment Sampling* programme was completed on 12 stations in the Regional network. During the year 3,500 bottled samples, 16 suspended sediment discharge measurements, and five bed material samples were collected. Sediment discharge computations for 1972 data were computed and approved for four stations by District personnel, the remainder being computed by the Sediment Section in Ottawa. A good portion of the summer work period was concentrated on two reservoir sediment surveys in the Toronto region — Clairville and Finch Reservoirs. Staff of both the Provincial Conservation Authorities Branch and Water Survey of Canada conducted the surveys.

Special Studies and Surveys Section

In 1973 several measurement programmes were carried out on the interconnecting channels of the Great Lakes. The programmes completed were:

1) Discharge measurements of the Niagara River at Fort Erie, at the International Railway Bridge section.
2) Calibration of the Leading Edge Flowmeter at Fort Erie.
3) A joint programme with the U.S. Corps of Engineers to measure discharge, storage and wave propagation as related to flow in the St. Clair River.
4) Calibration of the regulating weir in the Welland Canal at Port Colbourne.

Installation of the Niagara River Aerial Cableway was completed in September, 1973. The purpose of the cableway is to provide a direct measurement of the flow past the Ashland Avenue Gauge and to verify power plant discharge ratings. Joint discharge measurement programmes with the United States Corps of Engineers were also carried out.

This battery-powered, self-propelled aerial cablecar was installed on the Niagara River above the Robert Moses Power Plant is September 197 It will provide a platform from which it is possible to measure the discharge out of the Maid-of-the-Mist Pool. A Gurley-type velocity me suspended above a 100-pound sounding weight is used to measure the average velocity and depth across the metering section. The weight a meter are raised and lowered by an electrically powered winch. (Photo courtesy of the Power Authority of New York State).

Niagara River Studies and Control

This unit participated in the functions of both the International Niagara Committee and the International Board of Control.

Regular inspections were made to ensure that power diversions were made in compliance with the terms of the "1950 Niagara Diversion Treaty." On only one occasion was the flow deficient and that was a deliberate action of the International Control Structure Superintendent in the successful attempt to rescue ten people stranded on he Niagara River.

New operating procedures for the Chippawa Grass Island Pool were put into effect in March, 1973. The new procedures provide higher river profiles during low flow periods and lower river profiles during high flow periods.

The Leading Edge Flowmeter, which was installed to provide better control of the International Control Structure downstream, operated and collected data for a numb of months during 1973. A number of "bugs" have be eliminated from the system and rating of the Flowmet will be continued.

Data Control Section

This section is comprised of two main working group

1) Hydrometric Data Compilation and Quality Co trol.
2) Data Review.

In 1973 our major publication "SURFACE WATE DATA – ONTARIO 1972" was compiled, quality checke printed and distributed to various streamflow data us throughout Ontario. Requests were handled for more th 22,000 station-years of data, excluding miscellaneous da such as river cross-sections, velocity profiles, etc. As part

ur participation in the International Field Year on the Great Lakes, streamflow data for 37 discharge stations providing inflow into Lake Ontario was forwarded to the FYGL Data Bank at Canada Centre for Inland Waters for further distribution to participants, particularly the agencies involved in the Terrestrial Water Balance study of Lake Ontario.

The Data Review Section, which is involved in the review of all data collected to 1970, has completed approximately 30% of the total review programme. The initial phase of the programme was concentrated in the Northernmost basins, with review reports written for all hydrometric stations involved. Work involved the examination and revision, if necessary, of the data.

Network Planning and Forecasting Section

This section became operational in August, 1973. A start has been made on studies of regional water flow patterns to investigate the possibility of estimating (flood peaks, average flows, low flows) from existing data.

An Inter-District Seminar is planned for January, 1974 for the purpose of identifying hydrologic forecasting agencies that are now in operation, and to analyse the techniques which have been implemented to date across Canada.

Other projects completed by this unit were:

1) Implementation of a network planning classification of Ontario Region stations.
2) A review of 5 station records to be used in a UNESCO Study on large floods.

Environmental Protection Service

Environmental Protection Service

The Environmental Protection Service (EPS) was ormed to ensure that the Federal Government's legislation, egulations and guidelines concerned with the quality of the nvironment are approached in a fashion consistent with ational policy and enforced under appropriate circumstances. The Environmental Protection Service is involved the development of guidelines and regulations, in the identification and solution of pollution problems, problem surveillance and monitoring, and the development and demonstration of waste treatment technology. It draws on expertise from the Resource Missions of the Department for the criteria necessary to develop meaningful regulations, guidelines, and codes of good practice and for the conduct of research required to support EPS responsibilities.

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION DIVISION

The Technology Development and Demonstration ivision, Technology Development Branch, Water Pollution ontrol Directorate, is charged with the conception, evelopment, and implementation of technical development programs as related to water pollution control for dustrial and municipal wastewaters across Canada. The ivision not only undertakes bench and pilot scale studies their laboratories but also participates in field demonstraon projects at industrial sites.

To fulfill the mandate of the Technology Development ranch, EPS established a program at the Wastewater echnology Centre at the Canada Centre for Inland Waters CCIW). The Wastewater Technology Centre (WTC) is cated in a two-storey building at the North end of the CIW site. The building houses laboratories, and provides 395 m^2 (15,000 sq. ft.) of working area for a wide variety modular wastewater and sludge treatment process quipment.

The Wastewater Technology Centre bases its program iorities on the requirements of the Abatement and ompliance Branch of the Water Pollution Control Directrate, plus inputs from the various Regional Branches of PS and Provincial Environmental organizations.

In August, 1971, the Government of Canada and the overnment of the Province of Ontario signed an agreeent to ensure that the water quality of the Great Lakes is stored and protected. This "Canada/Ontario Agreement Great Lakes Water Quality" was signed in response to e recommendations of the International Joint Commission (IJC) concerning pollution of the Lower Great akes and in anticipation of the Canada/United States greement on Great Lakes Water Quality. The purpose of is Canada/Ontario Agreement was to permit Canada and ntario to effectively carry out their obligations under the ternational Agreement. An additional important ovision of the Agreement was for the conduct of a search program with a view to reducing costs of programs to achieve the specific water quality objectives set out in the Agreement. Thus, late in 1971, research programs were initiated on chemical removal methods, sludge handling, sludge disposal and other matters related to the process of nutrient removal from sewage. A major portion of the effort of the Wastewater Technology Centre has been directed toward the solution of these nutrient removal problems.

The staff of the Wastewater Technology Centre is organized into four main sections. These are the Process Development Section, Demonstration Section, Laboratory Services Section and Facilities Services Section, all supported by administrative personnel.

PROCESS DEVELOPMENT SECTION

The Process Development Section comprises four units organized along process lines: (1) biological processes, (2) physical processes, (3) chemical processes and (4) soil processes.

Biological Processes Unit

This group is responsible for carrying out developmental work on biological processes used to remove components such as BOD, suspended solids and toxicity from municipal and industrial wastewaters. A bioassay group, responsible for determining the fish toxicity of untreated waste streams and treated process effluents, is part of the biological processes unit.

Biological Treatment of Kraft Bleachery Effluent

A joint Federal/Industrial project initiated in 1973, involves the operation of a pilot-scale two-stage activated sludge system treating a Kraft bleachery effluent from the pulp and paper mill of Eddy Forest Products Limited, Espanola. The main objective of the program is to evaluate

the fish toxicity removal capabilities of the high rate activated sludge system. For comparative purposes, a single-stage conventional activated sludge process is being operated in parallel with the two-stage system.

The Kraft bleachery effluent being treated is the total effluent from a six-stage bleachery processing hardwood and/or softwood. The bleachery effluent is neutralized and pumped to the pilot-scale activated sludge systems at flow rates ranging from 2.27 to 22.7 l/min (0.5 to 5.0 Igpm). Performance of both systems is being monitored by conducting analytical and bioassay tests on 24-hour composite samples. These tests provide information for the determination of engineering design parameters and a measurement of the toxicity removal efficiency of each system.

Optimization of Biological Nitrification

A nitrification/denitrification pilot plant (22.7 l/min, 5 Igpm) program was carried out in conjunction with McMaster University in 1972 to investigate the feasibility of using continuous microbial denitrification for nitrate removal from municipal wastewater under cold temperatures.

Results from this study established that the critical link in a low temperature biological nitrification/denitrification system was in the nitrification step. Consequently, a pilot plant program was initiated in 1973 to examine various flow and process configurations for biological nitrification systems. Demonstration of process effectiveness under a range of operating conditions typical in Canada, is a further objective of this study.

Two pilot plant systems (Figure 1) have been constructed and are being operated as parallel systems using municipal wastewater as substrate. The two systems have been constructed so that six modes of operation can be studied; a bio-disc will also be used to study the nitrifying capabilities of a fixed film reactor. To provide a complete nitrogen balance, nitrified effluent will be denitrified in packed column reactors or a stirred tank reactor; denitrified effluent will be subjected to aerobic stabilization to remove excess methanol, the carbon source for denitrification. Preliminary experimental studies initiated in October, 1973, have been completed and the detailed experimental design is being formulated.

Biological Treatment of a High Strength Pulp and Paper Mill Effluent

Bench-scale studies were undertaken to investigate the possibility of using an activated sludge process for the treatment of the total mill effluent from a neutral sulfite semi-chemical (NSSC) pulp and paper operation. Samples for the study were obtained from Domtar's NSSC mill at Trenton. Untreated wastewater used in the original phase of the study had BOD_5 and total dissolved solids concentrations of approximately 7,000 mg/l and 25,000 mg/l respectively; these values have now increased to approximately 14,000 mg/l and 50,000 mg/l as the result of modifications in the water reuse program of the mill.

A single-stage and two-stage activated sludge reactor are being used in the laboratory studies (Figure 2). The major objectives of the study are to determine (a) wheth an activated sludge system will reduce the BOD_5 to a acceptable level; (b) the fish toxicity removal capabilities the activated sludge system; (c) sludge yield and oxyge requirements of the mixed liquor; and (d) the characteri tics of sludge generated to provide information for slud handling and ultimate disposal. Results indicate that a acceptable effluent BOD_5 level can be attained; howeve additional information is required before any conclusio can be drawn.

Aircraft De-Icer Treatability Study

A study was conducted at the WTC to investigate th feasibility of treating a combination of de-icing fluid ar airport wastewater using an activated sludge process. Th results were to provide information for the design treatment facilities at the new airport at St. Scholastiqu Quebec and for assessing treatment alternatives at oth airports across Canada.

Figure 1. Biological nitrification/denitrification pilot plant.

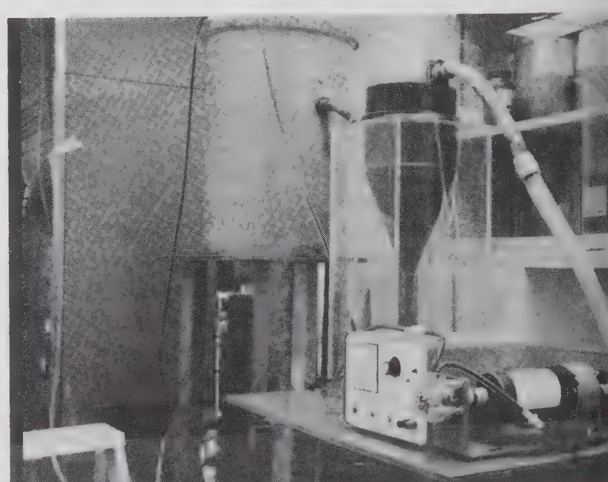


Figure 2. Single-stage activated sludge reactor treating NSSC fluent.

The first part of the program consisted of a bench-scale tivated sludge study to determine the optimum loading ndition and to obtain design parameters for the treat-ent of de-icing fluids and municipal sewage at low mperatures. A 91 l/min (20 Igpm) pilot plant was erated at the optimum organic loading to verify the sults from the laboratory-scale study and to determine nether there were any operational problems. The second rt of the program, consisting of bioassay studies, was rried out to determine whether the aircraft de-icing fluids d process effluents were acutely toxic to rainbow trout.

The experimental results showed that an activated idge system treating a combination of de-icing fluid and unicipal sewage at less than 10°C will produce an effluent ving a BOD_5 and Suspended Solids concentration of 20 g/l and 25 mg/l respectively at a loading of 0.15 kg OD_5/kg MLSS.day. Growth of filamentous micro-ganisms and the resulting sludge bulking condition ctated selection of the low loading condition. The oassay results showed that, at this loading, the concentra-on of de-icer in the feed solution would be such that the fluent from the activated sludge process would meet fish xicity requirements.

ysical Processes Unit

This group carries out research and development work physicochemical treatment processes for the removal of leterious and toxic constituents from industrial and unicipal waste streams. Active areas of concern include e development of design and operational criteria for the watering of municipal waste sludges, investigation of ysical-chemical treatment (PCT) processes for small mmunities and the treatment of wastes from base metal ining and metal plating industries.

w Brunswick Acid Mine Drainage Treatment Project

In 1972, a joint Federal/Provincial/Industrial study was itiated for the development of mine and mill wastewater eatment technology in the base metal mining industry. As result, two waste treatment pilot demonstration plants ve been established at the Brunswick Mining Company e in northeastern New Brunswick. The first plant on eam was a versatile pilot plant which incorporates ate-of-the-art technology for the treatment of acid mine aters. Unit processes include neutralization and precipita-on, sedimentation, sludge handling and effluent polishing. fluent metal concentrations obtained for several mine aters using state-of-the-art technology were as follows:

Mine water	Pb*	Zn	Cu	Fe
BMS # 12	0.3	0.42	0.04	0.36
Heath Steele	0.3	0.55	0.10	0.78
BMS # 6	0.3	0.52	0.06	0.54

*all values in mg/l

support of the field program, bench-scale development studies were carried out to assess the feasibility of alternative procedures and effluent polishing techniques. Excellent results were obtained with sand filtration, MgO reactor filters and polymer scavenging processes. Sand filtration and scavenging by polymers are presently under investigation in the pilot plant.

A second significant pollution problem also existed with the milling of the high sulphur content ores. Reduced sulphur compounds (thiosulfate and thionates) generated in the grinding and separation processes were escaping the mill in the tailings pond overflow. This caused a significant pH depression in the receiving water when naturally occurring bacteria oxidized these thiosalts to sulphate. Studies carried out at the Centre established the feasibility of two treatment processes: biological oxidation using a "bio-disc" and chemical oxidation in a stirred tank reactor using ozone. Sulphur precipitation also showed promise. Biological oxidation rates were approximately 29×10^{-4} and 11×10^{-4} kg thiosulfate per m^2 (6×10^{-4} and 2.2×10^{-4} lbs/ft^2) of reactor surface per hour at 20 and 2°C, respectively. The ozone reaction required approximately 30-40 minutes consuming 0.4 mg (lbs) of ozone per mg (pound) of thiosulfate oxidized. A "bio-disc" biological oxidation pilot plant is presently being constructed to demonstrate the technology and provide design data.

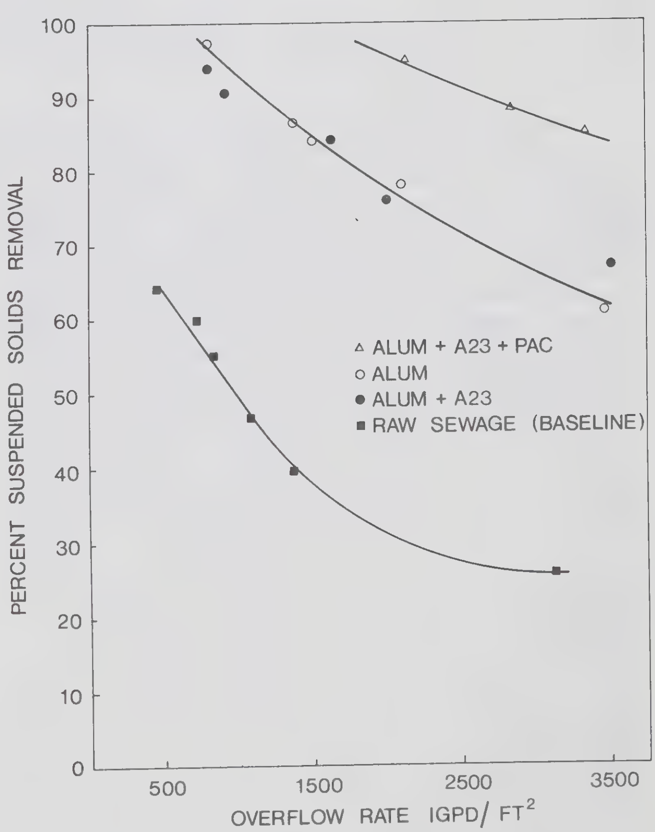


Figure 3. Settleability of chemically treated domestic sewage.

Table 1. Comparison of Percent Removals for Different Treatment Conditions

OPERATING CONDITIONS / PARAMETERS	BASELINE no chemicals added	200 mg/1 ALUM July 16-Aug 1	200 mg/1 ALUM 0.5 mg/1 A-23 Aug. 6-Aug. 31	200 mg/1 ALUM 0.5 mg/1 A-23 100 mg/1 PAC Oct. 3-Nov. 2
Total Organic Carbon (TOC)	13.4 (15.3)	30.9 (11.4)	45.7 (11.5)	48.6 (12.1)
Biochemical Oxygen Demand (BOD_5)	43.5 (13.0)	79.5 5.6	88.3 (2.2)	87.7 (4.0)
P	21.9 (14.3)	91.3 (4.2)	90.4 (11.2)	95.6 (3.2)
Suspended Solids (SS)	55.9 (16.6)	88.6 (4.1)	92.6 (4.4)	95.2 (2.4)
A1	–	37.4 (23.1)	63.7 (19.7)	83.9 (16.0)
Zn	–	81.2 (10.0)	83.3 (7.8)	71.1 (18.2)
Cu	–	87.6 (4.2)	90.2 (4.0)	88.2 (10.5)
Fe	–	76.6 (5.8)	76.1 (11.0)	90.4 (5.1)

Standard deviations are shown in brackets.

Table 2. Physical Characterization of Primary Sludge

	200 mg/1 ALUM		200 mg/1 ALUM + 0.5 mg/1 A-23* + 100 mg/1 PAC**	
PARAMETERS	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Concentration (g/1)	20.163	5.7	35.752	4.8
Volatile (%)	50.2	9.6	66.4	3.2
ρ Suspension (g/cm^3)	1.0057	0.0017	1.0079	0.0012
ρ Solids (g/cm^3)	1.73	0.28	1.39	0.11
Moisture Cake (%)	75.9	3.5	78.3	1.3
C.S.T. (Secs)	29.7	13.5	33.1	9.0
Resistivity (Sec^2/g)	2.797×10^9	1.14×10^9	0.982×10^9	0.42×10^9
Viscosity Filtrate (Centistokes)	1.47	0.22	1.04	0.04
pH	7.36	0.22	7.16	0.22
Filtrate Conductivity ($MMHOS/cm^2$)	1.16	0.24	1.25	0.15
Total Organic Carbon (mg/1)	115	81.2	109	33.6

* Polymer
** Powdered Activated Carbon

Table 3. Sludge Production – Primary Treatment

CONDITION	SLUDGE VOLUME 1/day (I gal/day)	TOTAL PHOSPHORUS mg/1	SS mg/1	VSS mg/1	SLUDGE WEIGHT kg/day (lbs/day)
seline	224 (49.3)	428.3	65,000	37,000	12.7 (28.0)
ne pH 9.5	440 (96.9)	1435.1	120,500	26,200	51.4 (113.0)
ne pH 9.5 idge Recycle	614 (135.0)	647.9	17,000	23,300	65.8 (144.7)
ne pH 11.2	991 (218.0)	415.7	75,300	15,100	71.5 (157.2)
ne pH 11.2 idge Recycle	991 (218.0)	444.1	100,900	15,200	100.0 (220.0)
0 mg/1 Alum	1778 (391.2)	239.6	18,800	9,900	33.2 (73.0)
0 mg/1 Alum).5 mg/1 lymer	1347 (296.4)	567.8	32,200	18,100	43.0 (94.7)
0 mg/1 Alum).5 mg/1 lymer + 0 mg/1 PAC	1414 (311.1)	458.8	34,700	22,600	48.7 (107.1)

S = Suspended Solids
S = Volatile Suspended Solids
C = Powdered Activated Carbon

ysical/Chemical Treatment for Small Communities

Under the "Canada/Ontario Agreement on Great Lakes iter Quality," a study was initiated to investigate and velop physical/chemical treatment processes for small mmunities. These small isolated sewage treatment plants, ving rural communities of a few hundred people or less, oically present unique design and operational problems iich are usually not encountered in large plants even ough the treatment process employed may be basically e same in both instances. Many of the problems are ectly related to the fact that small plants receive little aintenance and supervision. For satisfactory performance, e treatment system must obviously be highly dependable. oblems are also caused by highly variable organic and draulic loads under which small plants must operate. aracteristically, high surges of sewage over short periods d little or no flow at other times are experienced.

Pilot plant studies which have been carried out for the st year include the following unit processes: chemical irification, air flotation, powdered activated carbon, essure filtration, granular activated carbon in downflow cked beds or upflow expanded beds, and recarbonation. esults from a series of tests to evaluate alum and polymer -23) and powdered activated carbon (PAC) addition to w sewage are presented in Figure 3 and Table 1. Studies e continuing.

Sludge Dewatering Process Development Studies

The "Sludge Treatment Process Development Program" which was initiated in early 1972 under the terms of the Canada/Ontario Agreement, was aimed at the characterization of sludges with respect to physical (Table 2) chemical and biological properties and the correlation of these properties to efficiency of various sludge dewatering processes. The program was also to determine the effect of the various inorganic chemicals used in phosphorus removal on the present biological sludges (Table 3). The overall objective was to develop an understanding of sludge dewatering, either by sedimentation or filtration and to establish design criteria and methodology for the selection of process units based upon a knowledge of the influence of physical, chemical and biological properties of sludge on dewatering performance.

A study on "Chemical Treatment for Phosphorus Removal – Impact on Effluent and Sludge Properties" is a part of the overall sludge treatment development program. It was initiated in April, 1973, to investigate the following: phosphorus, carbon and suspended solids removal; heavy metal removal; sludge production; process operational characteristics; raw sewage settling; activated sludge settling; raw primary sludge characteristics; waste activated sludge characteristics and chemical conditioning. Many of the experimental studies have been completed. Studies

presently in progress include the addition of a chemical precipitant (lime) to the raw sewage of a primary treatment plant and the addition of a chemical precipitant (ferric chloride) to the aeration basin of an activated sludge process.

A second directly related study examines some sludge dewatering process units such as vacuum filtration, basket and solid bowl centrifugation, air flotation, thickening and plate and frame pressure filtration. Developing methodology criteria for the selection of process units, based upon a knowledge of the influence of physical, chemical and biological properties of sludge on dewatering performance, is the goal of this study. For this purpose mobile sludge dewatering test facilities will be used.

Chemical Processes Unit

This group carries out developmental work using chemical processes for the removal of undesirable and potentially harmful constituents from effluent waste streams. Of immediate concern and involvement is the removal of phosphates by chemical means.

Full-Scale Phosphorus Removal Studies

During 1973, the Chemical Processes Unit conducted full-scale phosphorus removal studies at Canadian Forces Bases (C.F.B.) Petawawa, Trenton and Uplands.

Alum addition to the primary was investigated at the Petawawa wastewater treatment plant. The response of the two-stage digestion process to the alum sludge was closely monitored. It was observed that the digester was capable of accumulating most of the phosphorus added to it for a period in excess of sixty days. As shown in Figure 4, this accumulation resulted in an improved supernatant quality.

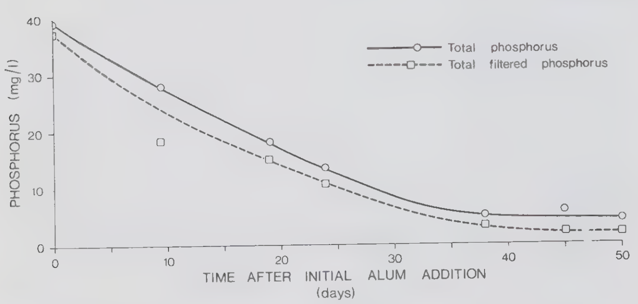


Figure 4. Effect of alum addition on digester supernatant phosphorus levels.

A full-scale study at C.F.B. Uplands compared the relative phosphorus removal efficiencies of alum and ferric chloride. Primary and secondary addition systems were evaluated for each chemical. The effect of Canada's detergent reformulation program (i.e., reduction of detergent P_2O_5 from <20% in 1972 to <5% in 1973) was clearly evident during the Uplands investigation. Figure 5 compares the average diurnal total phosphorus concentrations for the two years. The mean daily phosphorus loadings to the treatment plant were 26.0 kg (57.3 lb) and 11.4 kg (25.1 lb) for 1972 and 1973, respectively, or a loading reduction of 56%. Since the Base populat remained relatively static over the data collection peri much of this reduction can be attributed directly detergent reformulation.

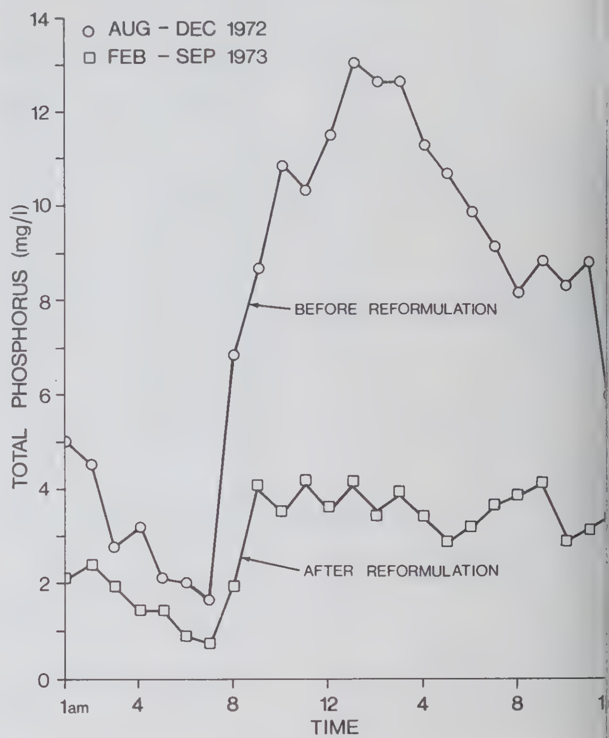


Figure 5. Diurnal variation of total phosphorus in raw wastew at C.F.B. Uplands.

A field station is being set up at the C.F.B. Bor wastewater treatment plant in order to carry out pilot-s studies on the sludge dewatering, incineration and chem recovery. Multiple-hearth and rotary kiln incineratior alum, ferric chloride and lime sludges will be investig during 1974. The feasibility of recovering and recyc lime/iron from the incinerator ash will be explored. pilot-scale incinerator and calciner that will be emplo are shown in Figures 6 and 7.

Utilization of Industrial Wastes and Wastes By-Products Phosphorus Removal

In this study funded under the Canada/Ontario Ag ment on the Lower Great Lakes, 141 Ontario and Que companies were contacted regarding waste products potential utility for phosphorus removal. An inventor waste products was compiled and several different type waste material produced by 48 separate companies evaluated for phosphorus removal efficiency by jar tes procedures. Several wastes with varying degrees of us ness were identified — i.e., pickle liquors, reclai $FeSO_4 \cdot 7H_2O$, mill scale, spent mine acid, carbide l stack precipitator dusts, dross, red mud and ce bag-house dusts and slags.

The geographical location of some of these waste terials is shown if Figure 8. As part of this project, l-scale phosphorus removal studies at a local wastewater atment plant (Dunnville, Ontario) using pickle liquor re closely monitored with respect to heavy metals levels the various plant streams. For all metals, with the ception of iron, there was no increase in metal transport through the plant in going from baseline to pickle liquor addition conditions. There were, however, significant increases in all metal concentrations in the mixed liquor, aerobic digester and waste sludge solids.

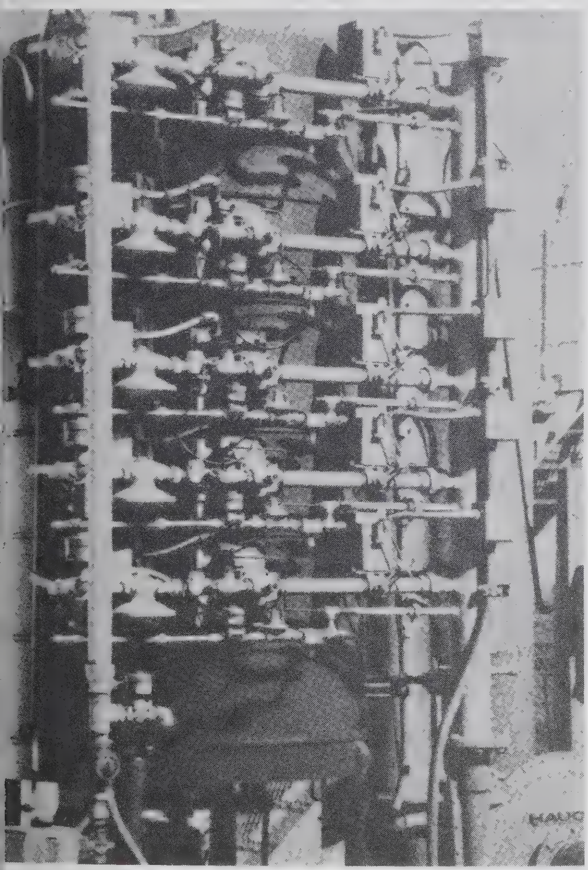


Figure 6. Multiple hearth incinerator, detail of burner system.

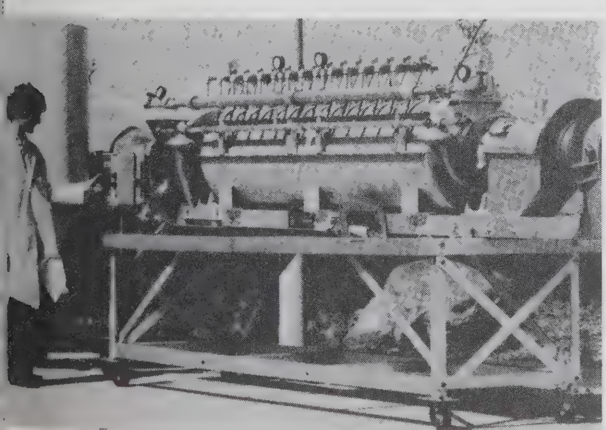


Figure 7. Rotary kiln calciner – overall view.

Tertiary Phosphorus Removal and Limiting Nutrient Studies

Pilot-plant experiments were carried out on the treatment of a stabilization pond effluent at Canadian Forces Station (C.F.S.) Lac St. Denis. The pilot plant was a 45 l/min (10 Igpm) chemical treatment system consisting of alum coagulation, flocculation, tube-settling and mixed media filtration components. Various alum and polymer feed conditions were evaluated over the 10-month period of continuous operation. Algal assays were carried out on the receiving water, Lac Depatie, to determine the limiting nutrient and to ascertain the effect of treated and untreated pond effluent upon algal growth. Phosphorus was shown to be the probable limiting nutrient in Lac Depatie and the tertiary phosphorus removal system reduced the phosphorus loading to the lake to an extent which should significantly reduce eutrophic conditions. As illustrated in Figure 9, treatment of the stabilization pond effluent greatly reduced its algal growth potential.

Water Quality Control Experiments on the Welland Canal

In May, 1973, the Saint Lawrence Seaway Authority (SLSA), treated a five-mile section of the abandoned Fourth Welland Canal with alum at an overall dosage of 5 mg/l as Al. The feasibility of this approach to water quality control had been established by experimental-basin studies carried out by the Chemical Processes Unit in 1972. The full-scale treatment involved distributing and mixing over 500 tons of liquid alum via a barge system as shown in Figure 10.

The water quality of the Fourth Canal was closely monitored during 1973 and it was observed that the alum precipitation significantly reduced the total and dissolved phosphorus levels of the canal water and consequently controlled water quality problems associated with summer algal blooms. The short-term effects of alum additions (i.e., reduction of phosphorus, and turbidity and increase in water transparency) are evident in Figure 11.

Other Projects in Progress (Funded Under the Canada/Ontario Agreement)

A) *Development of Predictive Models for Phosphorus Removal:* The objectives of this on-going project are:

(i) To establish a data bank, statistically analyse and derive trends from the "Treatability Data" collected as part of Canada/Ontario Agreement on the Lower Great Lakes.

(ii) To develop and verify statistical and chemical models for phosphorus removal on municipal wastewater.

B) *Effect of Citrate and Carbonate Based Detergents on Phosphorus Removal:* The objective of this project is to evaluate the effect of citrate and sodium carbonate based detergents upon phosphorus removal processes and to

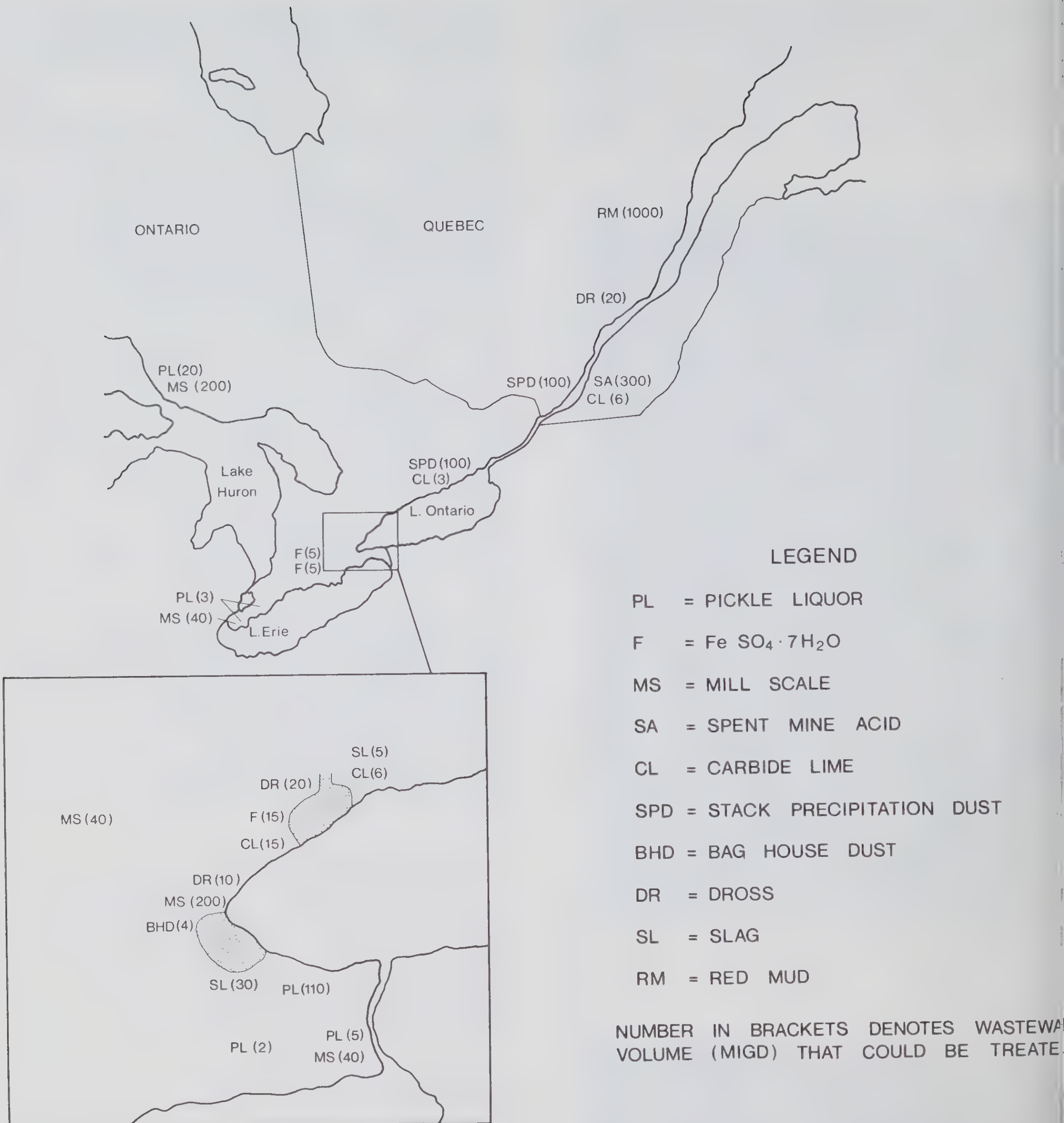


Figure 8. Geographical location of potentially useful industrial waste sources.

determine their general effect(s) on wastewater treatment plant operation. A citrate based detergent was evaluated for (i) potential phosphorus removal interferences by jar testing with ferric chloride, alum and lime, and (ii) biodegradability, potential metal transport and phosphorus removal interference by controlled full-scale detergent additions to an activated sludge plant at Waterdown. A carbonate based detergent was evaluated for potential phosphorus removal interferences on lime systems via jar testing and on a pilot 91 l/min primary lime treat plant.

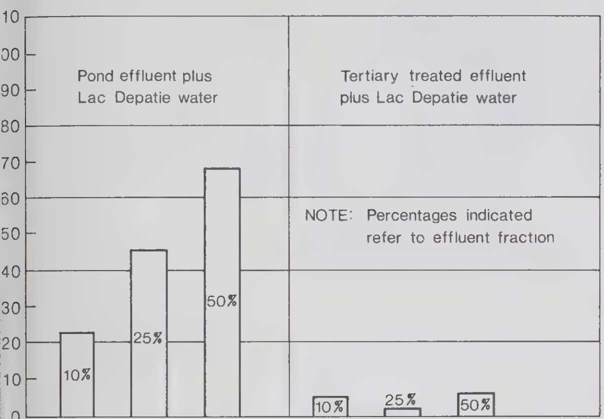
C) *Polychlorinated Biphenyls (PCB's) in Domestic W water:* In order to assess the magnitude of the chlorinated biphenyl (PCB) problem in the Lower Lakes a project was initiated with the following objec

(i) to determine, by sampling of selected O wastewater treatment plants, the concentr

of PCB's in raw and treated wastewaters and in primary, activated and digester sludges,

(ii) to determine the extent of PCB degradation within a conventional activated sludge treatment plant,

(iii) to determine PCB levels in typical combined and storm sewer discharges.



ıre 9. Effect of pond and tertiary treated effluents on the growth of Selenastrum in Lac Depatie water.

date, study results indicate that PCB levels in raw stewaters are generally low (<3μg/l.). Effluent levels are ısistently less than 1μg/l and with secondary treatment .1 μg/l. Relatively high PCB levels were encountered in ester sludges with some concentrations being in excess of 00 μg/l.

l Processes Unit

The chief area of responsibility of this group is in estigating methods suitable for the disposal of effluents l chemical sludges using soil systems. Areas of concern ısist of characterizing the leachate from the sludge soil tem and the role different soil systems play in removing ious constituents.

ure 10. Alum application barge used on Fourth Welland Canal.

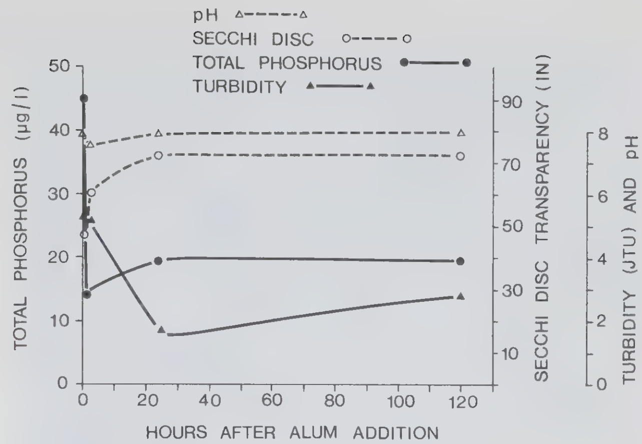


Figure 11. Short-term effects of alum treatment at section of the Fourth Canal immediately north of townline cut.

Biochemical Characterization of Chemical Sewage Sludges

Studies begun in 1972 concerning the biochemical characterization of chemical sewage sludges were continued in 1973. Digested sludges from four primary and secondary waste treatment plants practising phosphorus removal were characterized over an extended period of time in order to assess constituent variability trends. Between the four plants (Newmarket, North Toronto, Point Edward and Sarnia) the three most commonly used chemicals (lime, alum and ferric chloride) which are used for phosphorus removal are employed. Typical parameters investigated are summarized in Table 4. Significant variations in the concentrations of constituents in the sludges were observed over a one-year period.

Reclamation of Acid Mine Tailings

The objectives of this study were to ascertain if it was possible to reclaim and stabilize tailings resulting from mining operation. Mine tailings have pH values of approximately 2, while digested lime sludges from phosphorus removal systems have pH values of approximately 7.5. It was felt that lime sludge application to acid mine tailings would have a neutralizing effect. Bench-scale studies were initiated in 1973 to investigate this problem solution approach.

Liquid and dry lime sludges with and without sawdust added as a bulking agent were mixed with the top 6" layer of 18" deep mine tailings held in 1-foot diameter acrylic containers. After preliminary trials, liquid and dry lime sludge application rates as shown in Table 5 resulted in significant pH increases in the surface layers of the mine tailings in the various test containers. Figure 12 illustrates some of the preliminary data obtained.

Disposal of Chemical Sewage Sludges on Land Lysimeter Studies

The continued work from 1972 on this project saw two soil systems — Lisbon — loamy sand and Guelph — silt loam — established in the 66 lysimeters. In the spring, orchard grass (Frode variety) was planted on the lysimeter surfaces and three digested chemical sludges (alum, lime

Table 4. Biochemical Characterization Parameters Investigated for Chemical Sludges

PHYSICAL	NUTRIENTS	MINERALS	HEAVY METALS	PESTICIDES	PETROLEUM HYDROCARBONS
TS TDS TVS DVS pH Conductivity	TKN NH_3 Org. N Total P Sol.-P Org.-P Total C Org. C Inorg. C	Ca Mg Na K SO_4 Cl	Cu Zn Ni Cd Cr Fe Mn Al Pb	PCB-Arochlar 1254 Heptachlor Heptachlor-expoxide Aldrin p,ṕ – DDE Lindane γ – chlordane α – chlordane o,ṕ – DDT p,ṕ – DDD Dieldrin Thiodan–I Thiodan–II	Total Lipids Petro – HC n – alkanes Fatty acids

TS = Total Solids
TDS = Total Dissolved Solids
TVS = Total Volatile Solids
DVS = Disolved Volatile Solids

and iron-treated) were applied. Annual sludge application rates of 300, 600 and 900 KgN/ha were employed.

During the year, grass cuts from the various lysimeters and leachate analyses were carried out in order to establish nutrient and other constituent mass balances. The chemical composition, nutrients, heavy metals and minerals uptake were monitored to determine biochemical degradation of sludge constituents as well as their availability to the grass planted. Figure 13 summarizes the dry matter (D.M.) yields of orchard grass for various chemical sludges applied to the two soil systems under investigation. For reference purposes, yields from both soils when subjected to artificial fertilizer application (NPK) at a rate of 336 kgN/acre are shown.

Table 5. Lime Sludge Application Rates*

LIQUID SLUDGE		DRY SLUDGE	
Cubic Meters per Hectare	Lime Requirement**	Tons per Hectare	Lime Requirement
1.5×10^3	3.5	145	3.0
3.0×10^3	7.0	290	6.0
4.5×10^3	10.5	435	9.0

* Based on $CaCO_3$ content in the sludge
** Lime Requirement = 7.5 kg $CaCO_3$/t of tailings

Utilization of Dewatered Sludges

This project, dealing with the disposal on land of dewatered chemical sludges, was initiated and supported under the terms of the Canada/U.S. Agreement in 1973.

To-date, two soil systems – one, a heavy clay, the other a light sand – have been collected and repacked to natural field density in 48, 2-feet square polyethylene reactors with a soil depth of 30 inches. The experiments designed involve four application rates of three dewatered chemical sludges on the two soil systems in duplicate.

Recycling of Digested Sludge on Sand, Iona Island, Vancouver

A pilot-scale project to investigate the disposal recycling of primary digested sludge on sands has bee operation at Iona Island, Vancouver, since 1972. The objectives of the study are:

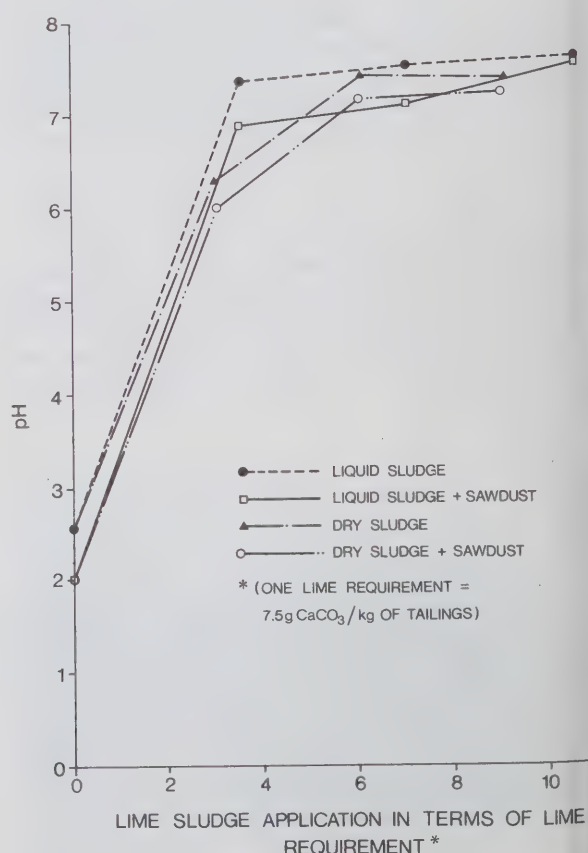
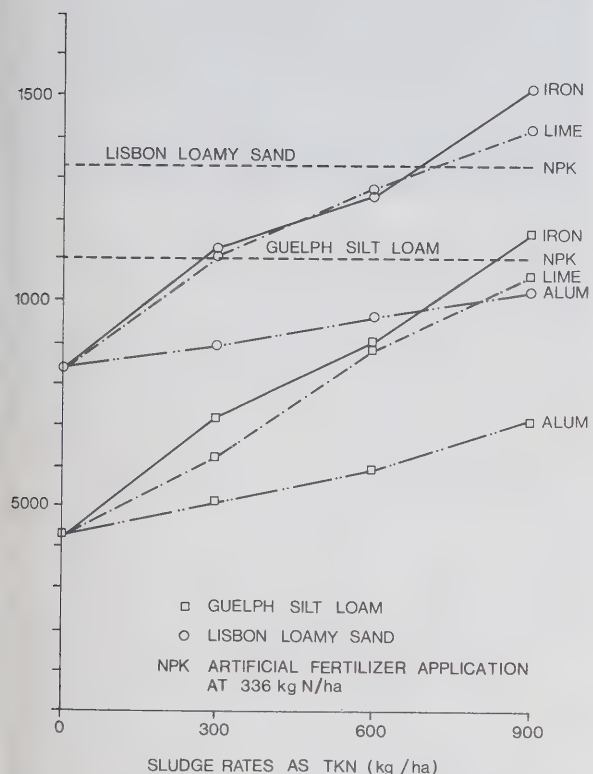


Figure 12. Surface (0-6") pH of acid mine tailings afte months of lime sludge application (Sept.-Dec. 197

(1) To investigate the optimum sludge application rate for efficient nutrient recycling on sand;
(2) To determine the biodegradation rate of digested sludges on land;
(3) To investigate the extent of accumulation of metals in soil, toxicity to plants and leaching of nutrients and bacteria to groundwater.



igure 13. Total dry matter (D.M.) yield of orchard grass, 1973 (4 cuts).

Sludge was added to four plots of 0.61 hectare each at tes of 0, 260, 475 and 1030 tons per hectare. A grass crop as established on all plots and three cuts were made ɹring 1973. Percolates from all plots are being monitored gularly for nutrients, metals and bacteria. A successful tablishment of grass crop on sludged sand is exemplified Figure 14. Studies are continuing in 1974.

emonstration Section

The Combined Sewer Sub-committee of the Technical ommittee on the Canada/Ontario Agreement on Great kes Water Quality developed a research strategy to be llowed within the framework of the Canada/Ontario greement in addressing the problem of combined sewer erflows. The purpose behind this research strategy was to apt and modify the EPA Storm Water Management odel for application to Canadian conditions. To facilitate is task within the budgetary and time frame available, a mber of projects were proposed by the Sub-committee.

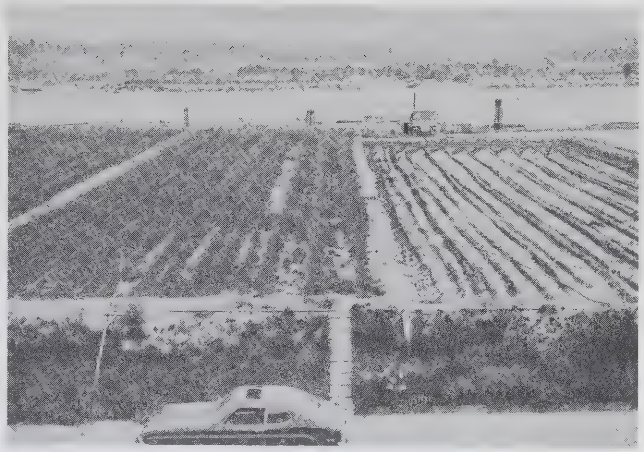


Figure 14. Grass crop on sludged sand – Iona Island.

The terms of reference for the development of a storm water management model were prepared and a call for research proposals was sent out by the Department of Supply and Services under the Canada/Ontario Agreement on Great Lakes Water Quality.

Mobile Laboratories

Specifications, drawings and purchase orders were prepared for two mobile analytical and one mobile bioassay laboratory.

Mobile Pilot Plants

Early in the year, two 45′ moving vans were purchased and modified for equipping as mobile pilot plants. A 25-ton flat bed trailer was specified and purchased to transport a multi-hearth incinerator from site to site to study the feasibility of recovery of precipitation chemicals used for phosphorus removal.

Laboratory Services Section

As in the previous year, this Section continued to supply the bulk of the analytical support required by the WTC projects. Approximately 31,000 samples were received from 29 projects requiring about 90,500 analyses of which 40,000 were metals. Although the parameters measured were largely confined to various forms of carbon, nitrogen and phosphorus plus heavy metals, sample types varied considerably including sewages, soils, grasses, sludges, lysimeter leachates and wastes from paper and base metal mining operations.

Because of the variety of sample types, considerable time was spent in proving and adapting techniques suitable for their general analysis, particularly for soils and sludges. Specific investigations were carried out for the following parameters:

1. Nickel and chromium in digester sludges,
2. Calcium in digester sludges and soils,
3. Phosphate in acid mine drainage containing high concentrations of iron,
4. Iron in plant tissue, and

5. Sulphate in samples containing reduced sulphur species.

During the year, the laboratory initiated a comparative analysis study on heavy metals in digester sludges among laboratories interested in the sludge disposal programs. This program now has ten participating laboratories, including federal, provincial and university groups. The laboratory also participated in the National Interlaboratory Quality Control Program initiated by Water Quality Branch of the Environmental Management Service for the analysis of nutrients and metals in water.

Facilities Services Section

The Facilities Services Section operates and maintains the various pollution control units in the Wastewater Technology Centre and ensures that services for new processes are assembled to meet design criteria generated by the Process Development Section.

During 1973, the nitrification/denitrification pilot plant was rebuilt, the physical-chemical pilot plant m ified to suit new program needs and the various slu dewatering process units were made operational.

Completion of the outside facilities now allows for improved operation of a 13.6 m^3/day (30,000 Ig extended aeration process, with sludge wasting, efflu sampling and influent control. A pilot ozonation proc for domestic and industrial wastes as well as two – m^3/day (10,000 Igpd) reverse osmosis units were sembled. One reverse osmosis model is of the spiral mod type using cellulose acetate film, while the other u hollow nylon fibres.

The supply of raw sewage for various process invest tions has been greatly improved with the installation back up pumping and automatic switch gear. Flow pressure were also increased and greater uniformity is r obtained after installing a comminutor. The permanent sewage distribution system is being utilized more quently, thereby streamlining the total operation.

Increased power requirements for the various pro units has resulted in reaching the present transfor capacity. Work has been initiated to remedy this situat

ENVIRONMENTAL EMERGENCY BRANCH

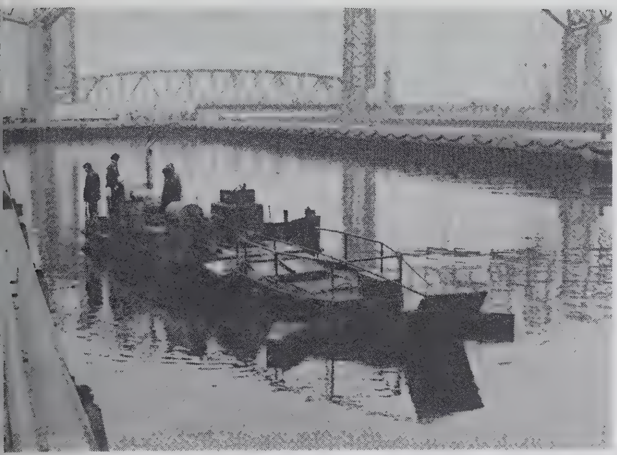
The Environmental Emergency Branch (EEB) which is part of the Environmental Protection Service has national responsibilities for protective and preventive activities where an environmental threat results from an accident in which a hazardous chemical is released into the environment. EEB is represented at CCIW by the Centre of Spill Technology (COST), formerly known as the Hazardous Material Spill Countermeasures Unit.

CENTRE OF SPILL TECHNOLOGY

The Centre of Spill Technology's working staff presently includes three research engineers, one geographer and two technicians. The projects conducted by this group encompassed local, regional and national problems.

Many of the projects have been undertaken in liaison with other groups and scientists at the Centre, with industrial companies, with university consultants and with other government agencies. The following projects were either completed or in progress in 1973:

1. Testing, evaluation and development of oil spill equipment including skimmers, pumps, transfer systems and booms was initiated. The programme was carried out in Hamilton Harbour and Lake Ontario. The MSD supplied vessels and coxswains for the field operation. Several oil spill systems including the JBF "DIP" and Lockheed Cleansweep have been evaluated and reports written this past year.
2. The testing and evaluation of oil spill trea agents continued at the Centre in co-opera with Ontario Ministry of the Environment, Un sity of Guelph, Sir George Williams University Inland Waters Directorate and private industry a result of this programme, the "Guidelines or Use and Acceptability of Oil Spill Dispersa was issued in August, 1973. The work is con ing and guidelines on the use of gelling and sin agents should be issued in 1974.
3. In conjunction with the Northwest Region – the problems associated with the restoratio land contaminated by oil and petroleum proc are being investigated. Field restoration wo areas of western Canada will be undertake 1974.
4. At the request of the Department of Nat Defence, COST reviewed the oil spill proble CFB Esquimalt, B.C. and presented recomm tions (1) for oil spill contingency planning an for oil spill countermeasures equipment and niques.
5. At the request of the Pacific Region – EPS, (is studying the problem and preparing re mendations for oil spill countermeasures a Port of Vancouver. This study will be comp in early 1974.
6. Jointly, with the IWD, projects related t Properties of Oil (2) Behaviour of Oil Spills (Tagging and (4) Mode of failure of oil co ment booms, are underway.



Evaluating "DIP" 2001 in South Slip of CCIW.

7. An on-going programme is a study of the methods available for cleaning and restoring shorelines which have been contaminated by oil. This programme will result in the preparation of a manual for agencies involved in such undertaking.
8. A remote sensing specialist, under contract to the EEB, was hired and is now co-operating with the Centre's Remote Sensing Section in all aspects related to the remote sensing of oil spills. In early 1973, an airborne microwave experiment was carried out at the Centre. This experiment was to test the feasibility of microwave in detecting spilled oil. MSD and Technical Operations co-operated in this work.
9. Engineering studies related to the microbiological degradation of oil spills on land and water, in co-operation with the WWTC — EPS are underway.
10. The planning of "Operation Preparedness" involving all DOE services at the Centre was initiated in 1973. The purpose of this study is to develop an "Action Plan" to deal with oil spills on the St. Clair River. In 1974, COST will be involved in the field testing and developing of the countermeasures.
11. Planning was initiated on the Beaufort Sea project which includes work on the detection, clean-up and disposal of oil spilled under Arctic conditions. A field programme will be undertaken in 1974.
12. A laboratory and field evaluation of the commercially available oil spill absorbents was undertaken in 1973. This programme will continue in 1974.
13. This year the Environmental Emergency — Technical Handbook was issued to assist operations personnel in cleaning up and handling of spilled oil.
14. Other areas of involvement were: (1) Participation with the U.S. Coast Guard on an oil spill equipment evaluation in Alaska; (2) Seminars across Canada on Dispersant Guidelines; (3) Outlining Research and Development work to the EPS' Regional Environmental Emergency Co-ordinators and (4) Observations on the field evaluation programme of the P.A.C.E. — Steltner oil containment boom.

Performance testing of Lockheed "Cleansweep" R2002.

Testing of absorbents at CCIW.

Fisheries and Marine Service

'isheries Research and Development Directorate

GREAT LAKES BIOLIMNOLOGY LABORATORY

GLBL conducts research programmes on the relation-ips among wastewater inputs, water quality and aquatic sources in the Great Lakes. Excess nutrient loadings, creased primary production and altered species com-sition at all trophic levels constitute cultural eutrophica-on, which continues to be examined both regionally and cally using a variety of approaches. Studies began on a ge scale in 1973 on the upper Great Lakes and planning as completed for studies on the effects of land use tivities on water quality in the Great Lakes. Both of these tivities, guided by IJC Reference Groups and the Great kes Water Quality Board, have required considerable rticipation by GLBL staff. All field work on Lake perior and portions of the work on Georgian Bay were mpleted in 1973 as part of the IJC Upper Lakes Reference udy. Studies on the impact of toxic substances, waste at and dredging activities were initiated in 1973 also der terms of reference of the Canada-United States reement on Water Quality in the Great Lakes.

The work of the Great Lakes Biolimnology Laboratory composed of three main programmes. These are, 1) scriptive Biolimnology and Surveillance, 2) En-onmental Toxicology, and 3) Ecosystem Metabolism udies. The programmes represent different but com-ementary approaches to the total array of problems, with ch programme differing in its needs for subdisciplinary pertise and logistic support.

Coordination of activities with other units at CCIW is cilitated in several ways, including the CCIW Management mmittee and its subcommittees (for example, Vessels signment), Scientific Council for Coordination and the vironmental Quality Coordination Unit.

scriptive Biolimnology and Surveillance

This programme is based on the examination of mmunities of algae, zooplankton, zoobenthos and fish (i) determine damage to aquatic resources, and wherever ssible causes, (ii) to establish baseline descriptions of uatic resources against which future changes, for better for worse, can be compared and (iii) to develop, escribe and apply surveillance techniques on a sound tistical and economical basis.

olimnology of the Upper Lakes

The major activity in 1973 was the sampling pro-amme for the Upper Lakes Reference Report. Samples re collected for lakewide surveys of chlorophyll *a* concentration, primary production, phytoplankton and zooplankton species composition and abundance. A benthos survey of Lake Superior and Georgian Bay was carried out in conjunction with a programme of sediment surveys in those areas.

Chlorophyll *a* concentrations in Lake Superior were determined at about 100 stations on six cruises from May to November, 1973. Average concentrations in the top 20 metres increased from 0.85 mg/m^3 in May to a maximum of 1.45 mg/m^3 in October. Vertical profiles obtained at 20 deep-water stations indicated that concentrations of chlorophyll were similar down to at least 100 m during unstratified conditions while during stratified conditions, especially in early August and September, there were frequent maximum concentrations of biomass just below the thermocline. The presence of these concentrations could be located by examining transmissometer traces. Primary production was determined by incubation of water samples with $^{14}CO_2$ in shipboard incubators and at several *in situ* moorings. Average values of carbon fixation obtained from approximately 50 stations ranged from 1.0 mg/m^3/hr in June to a maximum of 2.7 mg C/m^3/hr in September. In the relatively clear waters of Lake Superior the level of optimum primary production was 10-15 m.

On the July cruise, Dr. J. Verduin, Southern Illinois University, Carbondale, Illinois, joined the cruise and made estimates of CO_2 uptake by measurements of changes in pH. These values agreed with incubator measurements of ^{14}C uptake. Both sets of values are considerably higher, up to 10 times, than previous estimates of primary production in Lake Superior. The primary production values for the Superior are 2 to 3 times lower than those for Lake Huron exclusive of Georgian Bay and Saginaw Bay.

Initial results of the Lake Superior benthos survey indicate very low benthic populations, averaging only 400 to 450 individuals/m^2 in the main body of the lake. Localized areas of high faunal abundance occur near some population centres, and there is a general increase in total macroinvertebrates in the eastern third of the lake culminating in abundances of 1100 to 1500/m^2 in Whitefish Bay.

West of the Apostle Island region, the benthic fauna is composed of 62% *Pontoporeia affinis*, 21% Oligochaeta, 15% Sphaeriidae and 2% Chironomidae. In the main body of the lake, Nematoda and Sphaeriidae are codominant at about 27%, with *P.affinis* 23%, Oligochaeta 19%, and Chironomidae 3%. The taxonomic composition of Whitefish Bay benthos (39% Oligochaeta, 23% *P.affinis*, 17%

Sphaeriidae and Nematoda, and 3% Chironomidae) indicates water quality nearer mesotrophic in type.

Chironomidae, overwhelmingly dominated by the oligotrophic indicator *Heterotrissocladius*, occur mainly in the more productive near-shore areas just east of the Apostle Islands, north and northeast of Isle Royale, east of the Keweenaw Peninsula, and in Whitefish Bay. *Protanypus, Micropsectra, Tanytarsus, Paracladopelma*, and *Cryptochironomus* occur rarely.

The oligotrophic indicator *Stylodrilus heringianus* (Lumbriculidae), a species of *Mesenchytraeus* (Enchytraeidae) and a new tubificid taxon (Aulodrilinae) dominate the Oligochaeta. The former appears to be restricted to glaciolacustrine sediments while the latter two species are widely distributed in both consolidated and muddy substrates in the eastern three-quarters of the lake. A number of unidentifiable Enchytraeidae and the tubificids *Peloscolex variegatus* and *Rhyacodrilus sodalis* often occur in significant abundance.

Comparative Studies on Great Lakes Biota

Identification and counting of zooplankton from the Great Lakes, especially Lakes Superior and Huron were continued. A stratified counting system has been developed which provides better estimates than previously of both more numerous small organisms (nauplii and rotifers) and the larger, less abundant adult forms. Several comparison counts were made with other labs (Canadian Oceanographic Identification Service, Ottawa and State University of New York, Albany (Dr. D.C. McNaught). The results of these intercomparisons suggest that the system has good repeatability. Examination of the forms of *Bosmina* in the Great Lakes has involved the measurement and description of a large number of types. The taxonomy of one especially puzzling form is being investigated in detail. Analysis of horizontal distributions of zooplankton populations is being undertaken using similarity coefficients and cluster analysis techniques. So far, several techniques have been evaluated in order to find the best possible method of data reduction and presentation. Most zooplankton samples collected on 9 IFYGL cruises have been identified and counted and some vertical profiles of phytoplankton abundance at stations 19 and 11, have been calculated. Preliminary correlations with Chlorophyll *a* and nutrient and temperature profiles are underway.

Identification and counting of phytoplankton samples from the Great Lakes, especially Lakes Ontario, Huron and Superior were continued. Calculations based on these counts supported earlier estimates of high abundance of flagellates, especially small nannoplankton forms. The importance of these in total primary productivity of several lake systems was demonstrated in several experiments where separations of size classes of algae were made after incubation with $^{14}CO_2$.

Several papers were prepared in the past year summarizing the current state of knowledge of Great Lakes flora and fauna, emphasizing studies conducted at CCIW. These will appear in two issues of the Journal of the Fisheries Research Board of Canada as part of the regular April issue and in a special June issue "Limnology in Canada" commemorating the 1974 Congress of the International Association of Theoretical and Applied Limnology.

Surveillance of the Lower Lakes

During 1973, analyses of past data collected from the lakes has been carried out to evaluate it for the purpose of reporting on state of the lake and trend data. Difficulties involved relate to placing and number of sampling stations and frequency of cruises to provide data of suitable accuracy. Biomass parameters must be sampled frequently enough to describe seasonal trends, and, in the past, this has not always been done.

Environmental Toxicology

The general objective of this programme is the development of criteria for aquatic life (i) for toxic materials of specific concern in the Great Lakes, (ii) in relation to accumulation of hazardous materials in aquatic food chains. A more fundamental emphasis is on the sublethal effects of toxic substances, singly and in combinations on individual organisms as well as the biomagnification of pollutants in food chains and the physiological, and perhaps ecological, significance of tissue levels of contaminants.

Toxic Substances Studies

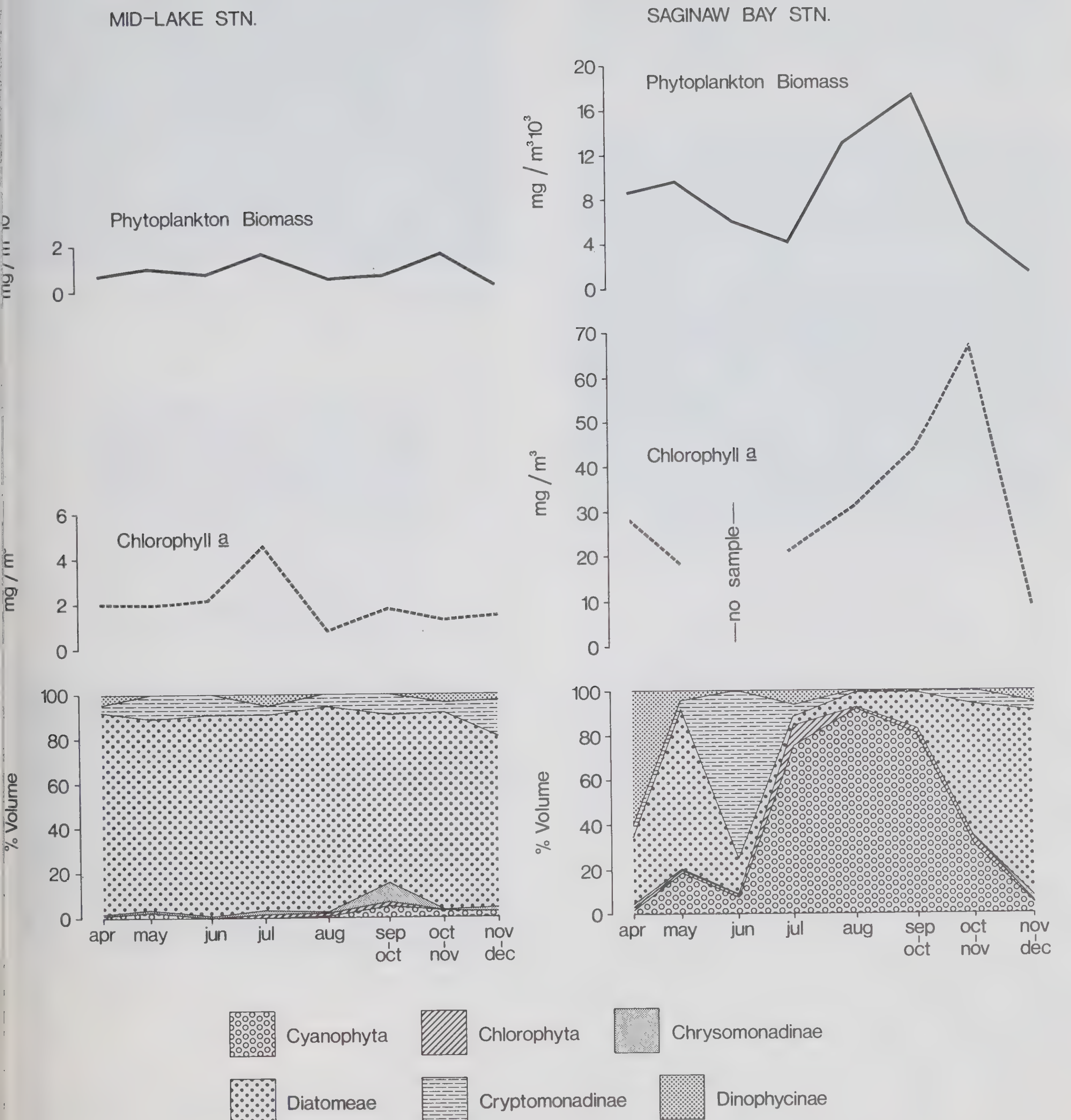
Initial work has and will involve the screening of several selected metals and organic compounds for acute toxicity on the organisms. This is to verify the techniques as well as the experimental results reported by established laboratories. Based on the results, in-depth studies on the sublethal effects will be carried out with two or three selected compounds each year.

Preliminary experiments with lead showed that organi lead (di- and tri-methyl) is more toxic to algae and bacteri than inorganic lead nitrate. Methylated leads at 1 ppm leve were found to inhibit 80% of cell division of *Scenedesmu quadricanda* whereas the same level of lead nitrate ha minimal effect. Moreoever, in a simulated lake system, th micro-organisms in the lake sediment were found to b capable of methylating lead nitrate as well as di- and tr methyl lead to the more toxic and volatile tetramethy form. The final conversion was more rapid from di- and tr methyl lead than from lead nitrate.

Other activities by the members involved laborator set-up, literature reviews, collecting and maintaining labor tory animals and visiting several well-established institutior engaged in similar studies.

Potential for Accidental Discharge of Toxicants

A 6-month contract in support of the Canada-U. Agreement on Great Lakes Water Quality, on hazardou polluting substances in the Great Lakes, was awarded t James F. Maclaren, Ltd., a Toronto environmental co sultant, in September 1973. The major tasks are enumerate data available in the basin or relevant sources o (1) the quantity of materials shipped by various modes transport; (2) the chance of accidental discharge occurri



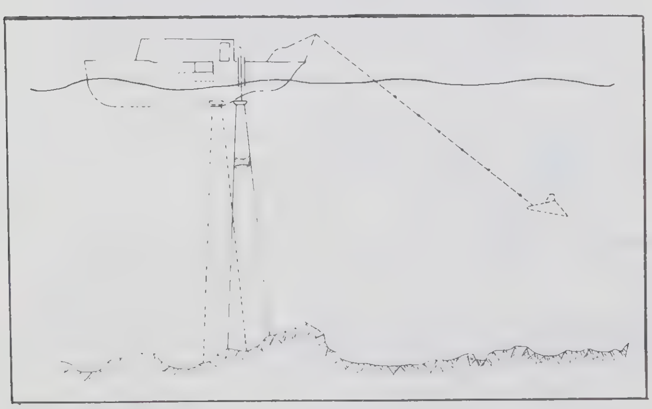
Differences throughout the season between a typical mid-lake station, Lake Huron and a station in Saginaw Bay in total phytoplankton biomass. Chlorophyll *a* concentrations and compositions by major groups. Note the relative importance of Cyanophyta (blue greens) in Saginaw Bay and Diatomeae (Diatoms) in the main lake and the occasional high abundance of flagellates (Cryptomonadinae and Dinophycinae).

associated with each specific mode of transport; (3) the accessibility of a spill to the water environment; (4) the size and nature of a spill associated with a particular mode of transport and (5) the toxicity of chemical materials to aquatic life. When the data are compiled, the toxicants will be rated with respect to the criteria and a list of toxicants, in descending order of potential hazard to the aquatic environment, will be produced. A final report is expected in April 1974.

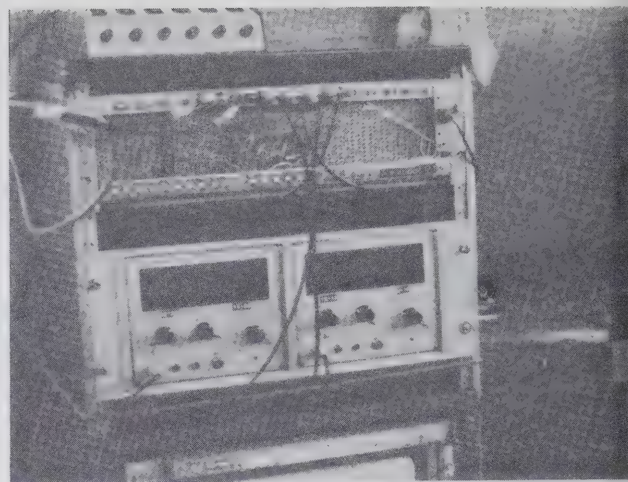
The 2160-Mwe Pickering Nuclear Generating Station, Lake Ontario.

Ecosystem Metabolism Studies

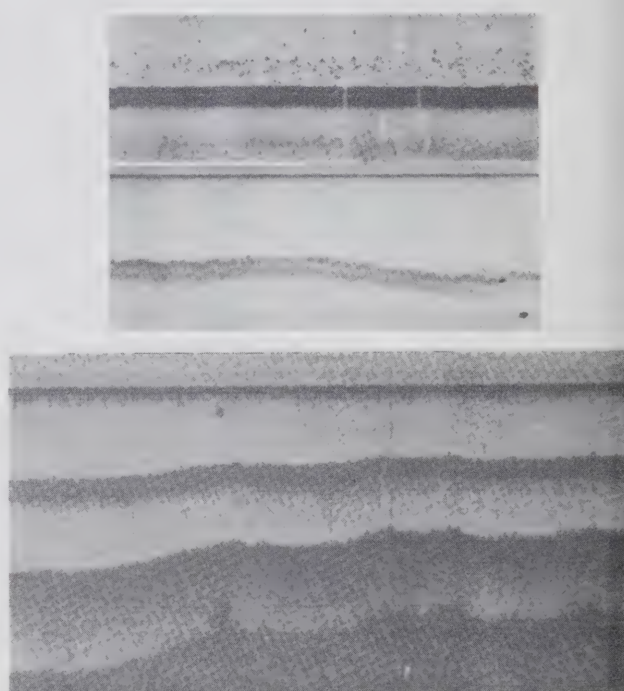
The general objective of this programme is to determine the extent of relationships among production at primary, secondary and decomposer levels and the manner and degree to which these relations are disrupted by environmental stresses, over space and through time in mixing zones, including pollution by toxic and oxygen-consuming wastes, waste heat, nutrient inputs, dredged spoils disposal.



Schematic of the echo counting system and towed thermistor array.



Equipment used in echo counting and temperature monitoring.



Echograms from the Pickering Nuclear Generating Station.

Waste Heat Studies

Studies at the 2160-Mwe Pickering Nuclear Generatin Station commenced in July, 1972. The major effort wa directed toward determining the effect of the therma discharge upon fish distribution, movement and behaviou R.G. Dowd, Marine Ecology Laboratory, DOE, Bedforc provided several electronic components necessary for system to acoustically assess pelagic fish abundance an distribution. The digital echo counting system was teste against trawls in Lakes Erie and Ontario and responde

directly to fish density and placement in the water column. Subsequently, it was used to determine density and distribution of fish in a region of Lake Ontario subjected to thermal discharge. Coincident with echo counts of fish, the thermal plume was recorded using a towed thermistor array which vertically profiled temperature. The thermal discharge appeared to advance the date of offshore migration at Pickering and delay the subsequent return of fish to the nearshore zone. Also, fish seemed to avoid the lateral aspects of plumes where isotherms tend to be compacted.

Ultrasonic tags were inserted in stomachs of a locally dominant fish, brown bullhead, and the movement and behaviour monitored at control sites and in relation to the thermal discharge. The thermal input caused fish to "mill" in the high mechanical energy areas of the plume and to move in a zig-zag fashion. Because they had to contend with high current, they swam at lower ground speeds. The association with the plume, however, was short term in nature as only 20% of fish released in the discharge were within its major influence the day following release.

To support field observations and to attain the expertise necessary for a trophodynamic study of nearshore perturbations, a number of laboratory studies have been initiated. Several manifestations of stress have been chosen, for example, ^{14}C uptake in phytoplankton and grazing rates in zooplankton. These responses will be used to examine immediate effects of thermal and also paper-mill effluents and to investigate the significance of entrainment. Since entrainment disrupts particles, electronic means of examining these changes have been assessed. Temperature exposure of Great Lakes organisms may vary between relatively stable to highly variable; these thermal regimes are being applied to a variety of local species to determine performance and success.

Paper-Mill Plume Studies

The purpose of this work, carried out at Marathon in Lake Superior mainly in July and August and in co-operation with Lakes Research Division chemists, was to determine if effluent emissions could be followed and sampled periodically to determine the dilution and degree of non-conservative behaviour of selected chemical constituents and energy. Drogues were used, with some inherent difficulties, to determine sampling points; conductivity and sodium ion were used to measure dilution rate. Some measurements of performance of the biota, were made, for example, primary production at various dilutions. The study will be refined and expanded and will be carried out in Nipigon Bay in 1974.

Project Quinte

Co-operative research on the Bay of Quinte (with Ontario Ministries of Natural Resources and Environment) was continued in order to determine the response by biota to the federal-provincial nutrient-removal programme from 1973 onward. GLBL staff worked with their Ontario colleagues on nutrient budgets of the Bay, primary production, zooplankton, benthic macroinvertebrate communities and general limnology. Plans were made to work together to produce a report which will summarize what is known about the limnological characteristics and behaviour of the Bay of Quinte.

Spoil Disposal from Dredging Operations

Studies on the effects of dredged-spoil disposal were initiated in 1973 in a co-operative study with the Ontario Ministry of Natural Resources and other groups under terms of reference of the Canada-U.S. Agreement. The work in Lake Erie offshore from Port Stanley included phytoplankton and zooplankton bioassays of serial dilutions and ambient water during spoils disposal, examination of benthic macroinvertebrate communities before and during spoil disposal, and finally, evaluation of usefulness of electrical-acoustic fish census techniques to determine response of fish to spoil disposal events. The latter technique will be of extreme value in future work on fish, and, in addition, it is possible to examine the pattern of solids sedimentation in time and space in relation to specific disposal events. The other site used in 1973 was the pilot-scale artificial island in Lake St. Clair where samples of the benthic macroinvertebrate community were taken and similar bioassays of spoils were conducted. This work will be intensified in 1974, not only in field studies, but also in the laboratory employing lake-column simulators which will be loaded at various rates with a variety of dredged materials.

Joint Programmes with Universities

During 1973 GLBL staff co-operated on several projects with university colleagues through supervision of FRD Grants, development of contracts, and in some cases, by lending assistance in the supervision of graduate studies. Those involved included Dr. J.M. Bristow, Biology Dept., Queen's University — a study of aquatic macrophytes in the Bay of Quinte; Dr. R.W. McCauley, Biology Dept., Wilfred Laurier University — the relationship between varied thermal history and thermal preference in fish; Mr. E.E. Pickett, Institute of Environmental Studies, University of Toronto — development of surveillance strategies for the Great Lakes; Dr. J.C. Roff, Zoology Dept., University of Guelph — IFYGL Lake Ontario zooplankton studies; Dr. J.B. Sprague, Zoology Dept., University of Guelph — Bay of Quinte studies; and Dr. G.M. Sprules, Biology Dept., Erindale College, University of Toronto — zooplankton community structure in Ontario Lakes; Dr. C. Mayfield, Biology Dept., University of Waterloo — effect of detritus on toxicity of pesticides.

Marine Sciences Directorate (Central Region)

T.D.W. McCULLOCH, Directo

HIGHLIGHTS

Several organizational changes occurred during the year. A Research and Development Division was officially established under the leadership of Mr. N. Freeman. This was previously known as the Geotechnology Division.

Mr. A. J. Kerr was appointed Regional Hydrographer early in the year. Mr. H. Blandford who had been acting in this capacity was transferred to Headquarters as the Chief of Planning and Development. The Hydrographic Division took over the responsibility for surveys in Hudson Bay and James Bay, at the same time withdrawing its western boundary to the Saskatchewan-Manitoba border. The responsibility for Tides and Water Levels was transferred back to the Hydrographic Division from Research and Development. Plans were made for the transfer of the Tidal Instrument Group from Headquarters.

Field participation in the I.F.Y.G.L. (International Field Year for the Great Lakes) program was terminated early in the summer after completing the bathymetric survey of Lake Ontario and closing down the Decca positioning system.

Probably the major project of the year resulted from the abnormally high lake levels during the spring. Under an agreement between the Canadian Government and the Government of Ontario, a joint program to study Shore Property Damage and Shore Erosion was set up. This program costing a total of $700,000, shared equally by both governments, involved both the Department of the Environment and the Department of Public Works. Several sectors of D.O.E. were involved.

Hydrographic Surveys in the Arctic were emphasized. The Ministry of Transport light icebreaker 'NARWHAL' was again used in James Bay, completing the navigable corridor into Fort George. C.C.G.S. 'N.B. MCLEAN' was also used for a short reconnaissance survey in Chesterfield Inlet. Further north, the Polar Shelf Project team surveyed Norwegian Bay and hydrographers from Central Region participated in two icebreaker probes aboard 'JOHN A MACDONALD' to Victoria Strait and 'LOUIS ST LAURENT' to the Ringnes Islands.

A pilot project for a major tidal current study in th Lower St. Lawrence was carried out by the Research an Development Division using C.C.G.S. 'PORTE DAUPHINE' Summer and winter physical oceanographic measurement were undertaken in James Bay in support of an Ocean impact assessment of the James Bay Power Development Two scientific contracts were let: 1) to develop operation techniques for storm surge forecasting on the Great Lake and 2) to analyze and interpret the physical oceanographi measurements on James Bay.

A major hydrographic survey of Lake Winnipeg, whic is planned to extend over five years, was initiated. Thi survey used a Mini-fix positioning system and Bertran launches.

Another contract was let for a hydrographic survey o Georgian Bay to the value of $100,000 with COMDE Marine again winning the contract. The results of the surve have been appraised and considered to be very satisfactory

The hydrographers' exchange program with U.S. Lake Survey was again carried out with the Canadian hydrog raphers not only visiting Great Lakes Survey parties bu also National Ocean Survey groups in the southern state

The automation of hydrographic surveys may b considered to have come of age. A very successful surve utilizing the HAAPS (Hydrographic Acquisition and Proce sing System) was used in James Bay and earlier in Lak Ontario and Lake St. Clair.

Two minor research vessels were acquired. 'ADVENT a fast cutter, 77 feet in length and 'HILDUR', 106 feet i length. 'HILDUR' which had originally been built as research vessel in Norway was purchased from the estate o the late T. E. Eaton.

In summary, this was another successful year fo Central Region with a number of new programs bein undertaken and a vigorous approach to increasing the scop of the work.

CANADIAN HYDROGRAPHIC SERVICE

A. J. KERR, Regional Hydrographer

INTRODUCTION

Central Region had another very successful year during 1973. Forty-six Field Hydrographers were actively involved in supporting Central Region Programs which covered mar areas of our geographic responsibility.

These programs were carried out under the direction o Mr. A.J. Kerr, who was appointed to the position o

Regional Hydrographer early in the year.

Eight major surveys were undertaken in 1973 in ddition to a number of smaller surveys.

In the Northern Arctic, two programs were carried out. A through-the-ice bathymetric survey of Norwegian Bay nd a Decca Signal Velocity study in Amundsen Gulf.

Further south, a major survey was continued in James Bay where a navigation corridor was completed between La Grande Rivière and Hudson Bay. In Chesterfield Inlet, on he Northwest side of Hudson Bay, a reconnaissance survey was undertaken to prepare for a major effort in 1974.

In the western area of the Region, parties operated on Lake of the Woods and on Lake Winnipeg. At Lake of the Woods, the survey concluded a seven-year effort to chart he waterways. The Lake Winnipeg survey was the first year f a planned five-year program to survey the northern half f the Lake and complete detailed surveys of all the Lake's arbours.

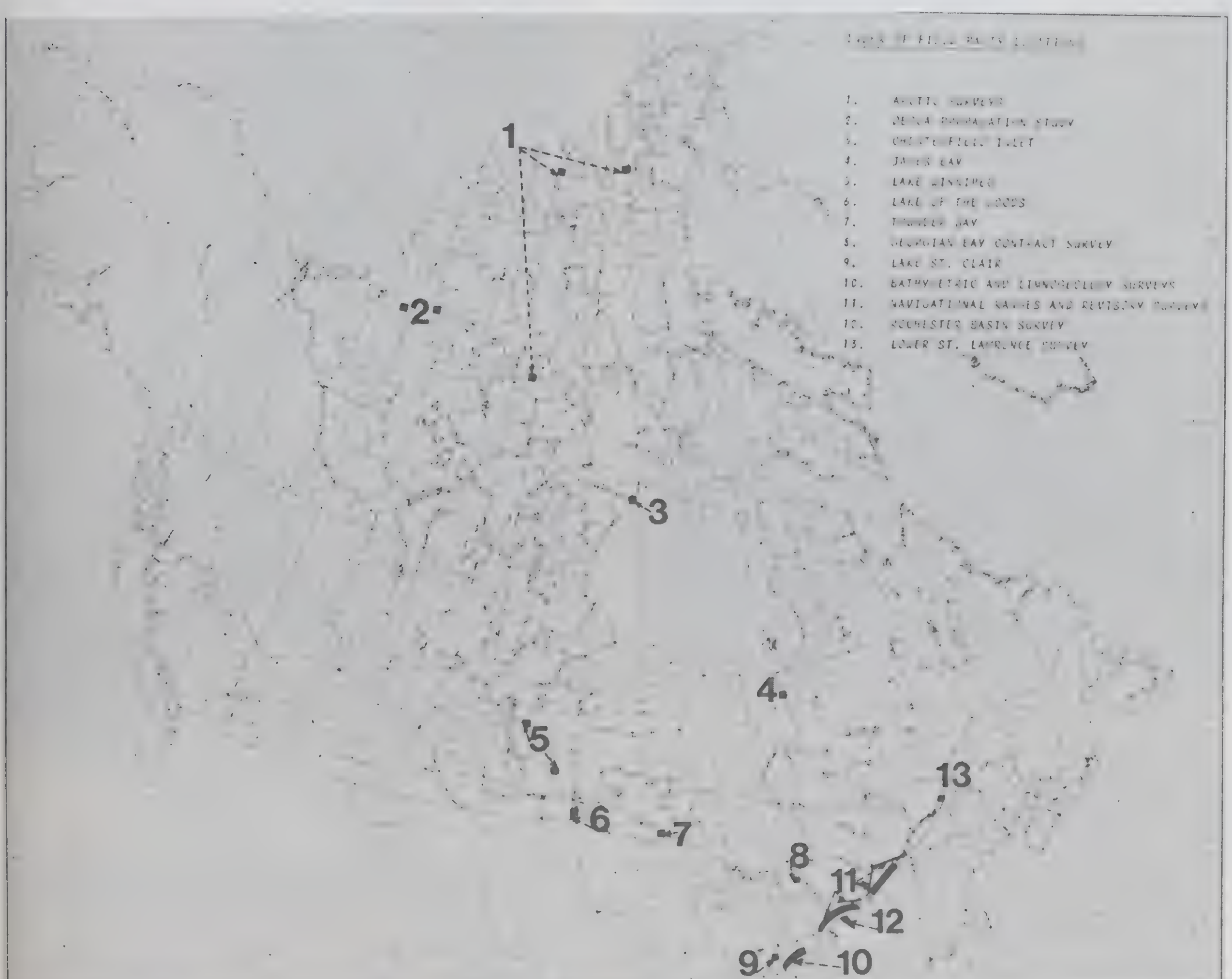
Closer to home, a good number of activities were nderway in the Great Lakes. On Lake Erie, hydrographers gain supported the I.W.D. Limnogeology program in addition to collecting standard hydrographic data. A complete re-survey of Lake St. Clair was undertaken. The charting of this area will be a cooperative program with the U.S. Lake Survey Center. The Bathymetric program on Lake Ontario, which was part of the International Field Year for the Great Lakes, was completed early this year.

On Lake Superior, a horizontal control operation was completed at Thunder Bay to prepare for a full Hydrographic survey in 1974.

In 1973, the Region contracted its second complete hydrographic survey and provided continuous monitoring to the project. The results of these surveys in Georgian Bay are a clear indication that private industry, if monitored and guided, can provide hydrographic survey data to C.H.S. specification.

The most easterly survey was on the Lower St. Lawrence River. It was the fifth season on this project with another two years anticipated to reach Québec City.

The systematic Revisory Survey, required to maintain charts up-to-date, was continued. The Navigational Ranges Survey was also continued and all Ranges between Niagara



Surveys – 1973.

and Kingston were accurately determined.

Generally, the surveys had an obvious basic hydrographic orientation; however, many of our hydrographers had some involvement with other disciplines. The James Bay Survey staff were very much involved in an oceanographic program, while on Lake Erie hydrographers worked on a Limnogeological program. Locally, staff were assigned to the R & D Section primarily to work with the Hydrodynamics and Shore Properties Groups.

During the latter part of the year, a Tides and Water Levels Section was established within the Division with the aim of becoming more actively involved in water levels and horizontal movements which affect navigation.

1973 was the second year of a technical exchange program with our counterparts south of the border. This exchange was again very successful and will be continued in 1974.

This year, side scan sonar operations were introduced into all of the major surveys. The sonar unit, with a competent operator, was rotated between the field parties. This system was successful not only in detecting possible navigation hazards, but with exposure to many hydrographers, its future potential and operational capabilities were clearly demonstrated and received with enthusiasm. In addition to its use on standard surveys, the sonar unit was used to study sand wave formation on the St. Lawrence River. Very interesting results were obtained.

R.P.S. scanner fitted to Bell 205A helicopter.

The Development Group was again very busy during 1973. The instrumentation efforts were directed mainly towards Side Scan Sonar, Loran-C, Integrated Sat-Nav and Doppler Sonar navigation systems and HAAPS hardware. In data processing, efforts were concentrated on getting the most out of the Gerber 22 plotting system. Results achieved were most gratifying.

A senior hydrographer of the Region was assigned to Algonquin College to instruct on the Hydrography I Course. In addition, Pacific Region was assisted greatly by the assignment of three experienced hydrographers to WILLIAM J. STEWART and CSS PARIZEAU.

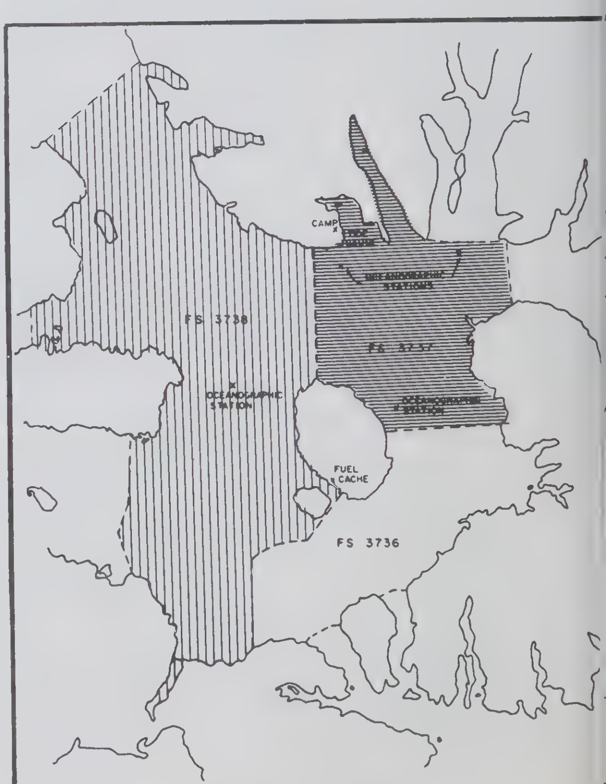
During 1973, two hydrographers took advantage of University Training Plan. In addition, many others t courses on a part-time basis in order to advance t technical capacity.

The Cartographic Section of the Region, although v small, made a very important contribution to our Divis and the Directorate, as did the Marine Information Hydrographic Data Centres.

Without the support of other Divisions of the Regi Hydrography could not function. We appreciate excellent support received in 1973 and look forward continued cooperation in 1974.

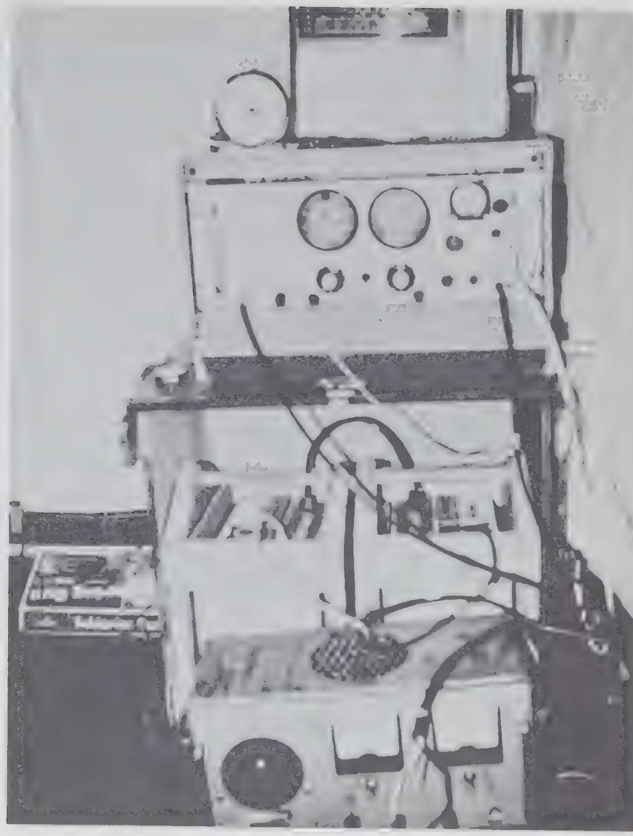
ARCTIC SURVEYS

Hydrographers worked for yet another year with Polar Continental Shelf Project. Partially in response to needs of the oil companies for improved bathymetry, partially to ensure the safety of icebreakers en rout Eureka, a bathymetric survey of Norwegian Bay completed. This survey used helicopters and through sounding methods. Hydrographers also worked in Amu sen Gulf where a joint Regional/Headquarters experim was carried out to compare the propagation velocity Decca signals over both ice free and ice covered waters.



Norwegian Bay field sheet layout.

Typical Surprise Fiord visitor.



Equipment layout for velocity propagation study.

James Bay field sheet layout.

Base camp, Surprise Fiord.

JAMES BAY AND CHESTERFIELD INLET

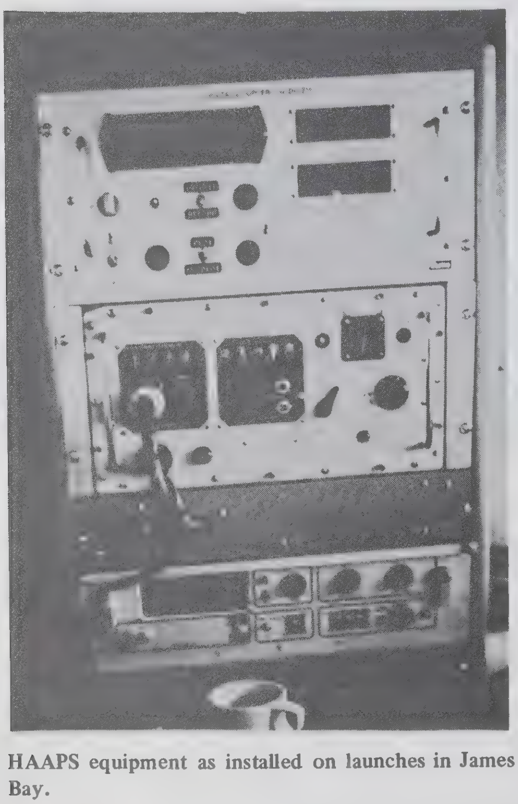
For the second year, a very successful combined ydrographic/Oceanographic survey was conducted in mes Bay. The results of this survey provides a 5-mile wide e shipping route from Cape Jones to Fort George.

This was a fully automated survey using the Hydrographic Acquisition and Processing System (HAAPS).

During the field season, two oceanographic cruises were conducted in the northern part of James Bay.

In preparation for a major survey planned for 1974, a reconnaissance survey was conducted in Chesterfield Inlet. The purpose of this operation was to gain familiarity with the area and establish sufficient horizontal control for sounding operations in 1974.

Oceanographic observations being taken in James Bay.



HAAPS equipment as installed on launches in James Bay.

C.C.G.S. N.B. MCLEAN in Chesterfield Inlet.

NORTHERN ICEBREAKERS

This year, Central Region provided two hydrograph for Icebreaker service in Arctic waters.

Two icebreakers were manned, namely the C.C.G LOUIS ST. LAURENT and the C.C.G.S. JOHN A. M DONALD.

The 1973 Navigation season in Arctic waters, un the previous year, was relatively ice free and therefore g the Canadian Hydrographic Service an opportunity to g valuable bathymetric data by the track sounding meth

The C.C.G.S. LOUIS ST. LAURENT conducte reconnaissance survey along the west side of Ellef Ring Island, eastward through Belcher Channel and southw through Penny Strait. The C.C.G.S. JOHN A. M DONALD conducted a reconnaissance probe thro M'Clintock and Peel Channels, as well as Victoria Strait.

LAKE WINNIPEG AND LAKE OF THE WOODS

A major hydrographic survey party was deploye Lake Winnipeg in 1973. The Manitoba Hydro Project the Nelson River, and a developing tourist industry, h made the requirement for modern navigational chart Playgreen Lake and Lake Winnipeg essential.

The survey was conducted using a 50 watt Min system and MRB-2 Hydrodist system with all data comp and portrayed by the Hydrographic Processing Sys (HYPOS). The hydrographic data collected will enable passage of ships for one-quarter of the northwest portio the lake in the area of Grand Rapids.

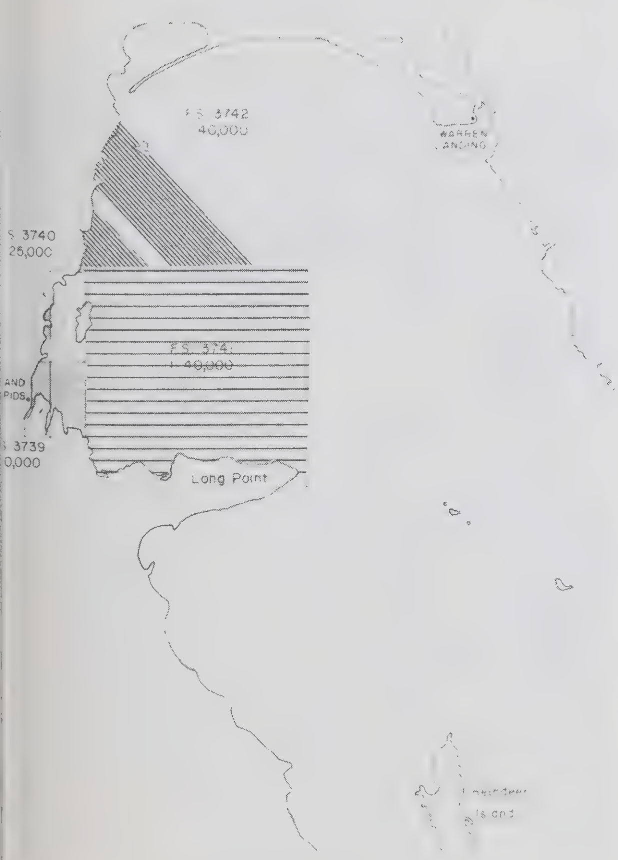
A mobile survey party was stationed in Gi Manitoba, and established a horizontal control netw which will enable the production of photogrammetric p for use in 1974 surveys.

It may be interesting to note that present p indicate that a new revamped HAAPS system wil utilized in Lake Winnipeg during the 1974 survey.

The 1973 hydrographic survey of Lake of the W was a continuation of the project started in 1967. S

Track soundings from C.C.G.S. LOUIS ST. LAURENT.

examinations were completed on all remaining field sheets and revision made on some of the earlier field sheets.



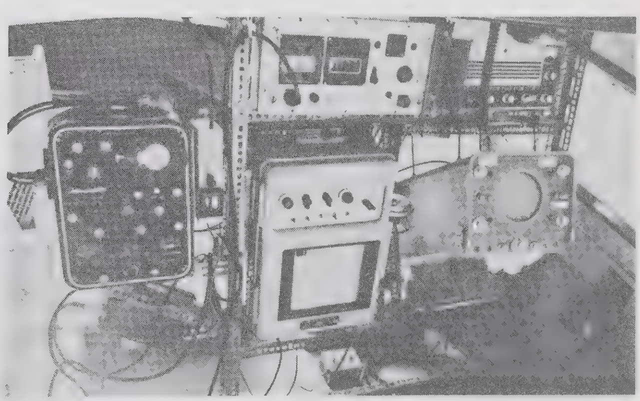
Lake Winnipeg Survey, 1973.

GREAT LAKES SURVEYS

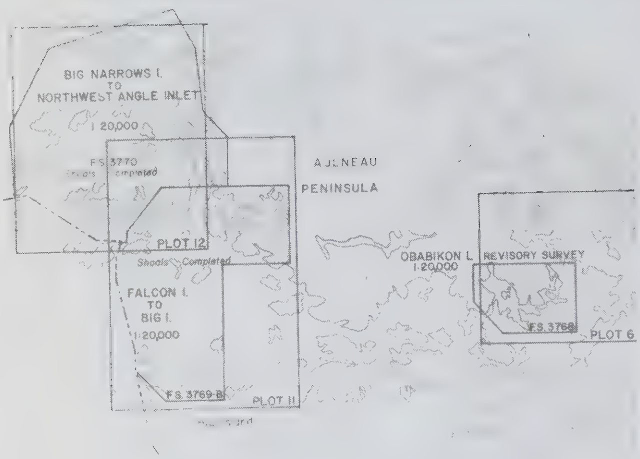
Lake Erie – North Shore

This year, as before, limnogeology support in Lake Erie continued. Our involvement consisted of supplying a navigational survey system and the expertise in checking positioning and depth record quality. At the same time, this operation provided sounding coverage with wide-line spacing.

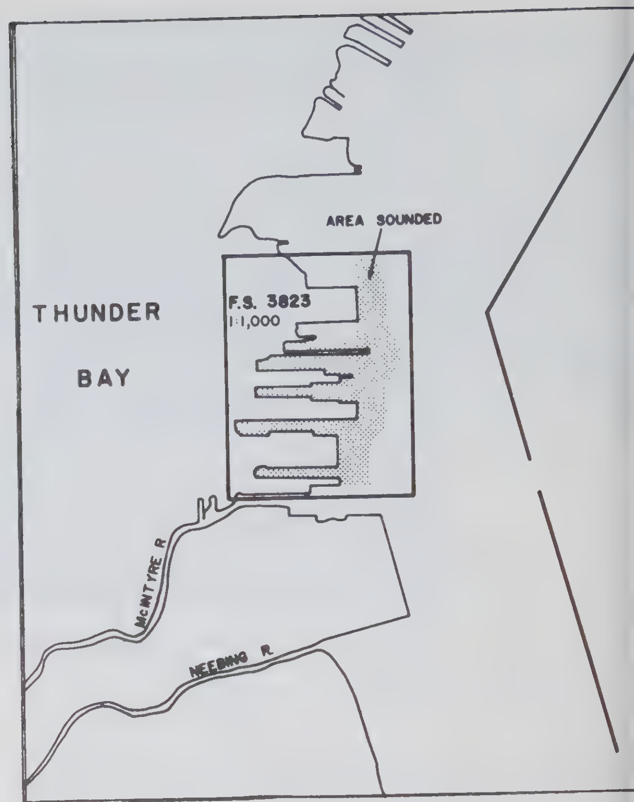
In order to bring the sounding coverage up to C.H.S. standards, a small hydrographic survey party was operational to add additional bathymetric detail.



Typical Mini-fix/Hydrodist equipped launch.



Lake of the Woods Survey, 1973.



Thunder Bay field sheet layout.

Lake St. Clair and Thames River

In 1973, priority was given to a survey in Lake St. Clair in a cooperative venture with the U.S. Lakes Survey, for the purpose of issuing a new edition of the U.S. Chart.

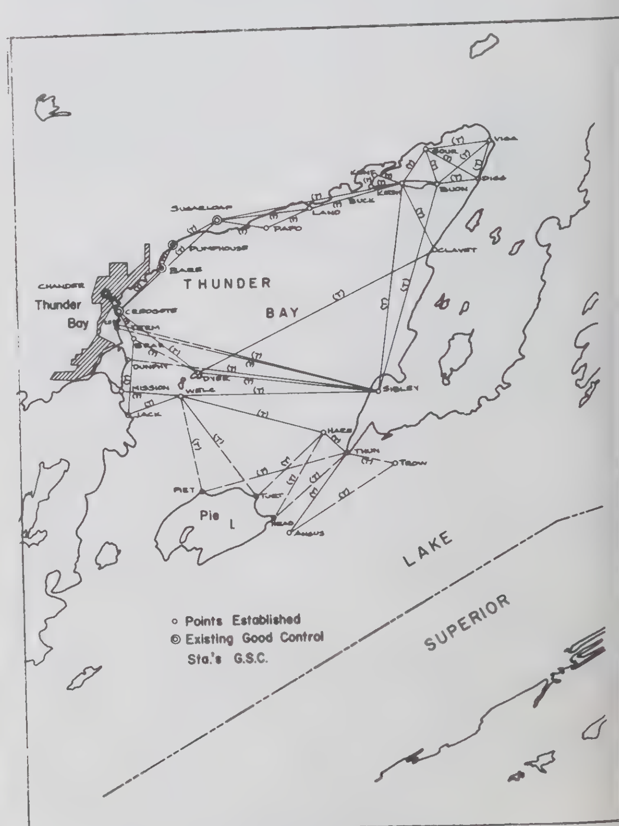
A Motorola Range Positioning System was used for positional data and all parameters were logged by the Hydrographic Acquisition And Processing System (HAAPS).

The Thames River, which is used extensively by large cruisers and small pleasure craft, was surveyed at a natural scale of 1:10,000. This was a reconnaissance survey using air-photo interpretation for positioning. The side scan sonar was used to locate obstacles and shoal areas.

Lake Ontario — Rochester Basin

This was an extension of the HAAPS bathymetric survey of Lake Ontario, started in 1972. This survey was implemented to more fully develop the intricate bathymetry of Rochester Basin.

Thunder Bay Harbour.



Thunder Bay Control Layout.

hunder Bay

Horizontal control was established around Thunder ay to facilitate the location of electronic positioning ystems for future surveys and to establish accurate control or the production of photogrammetric plots.

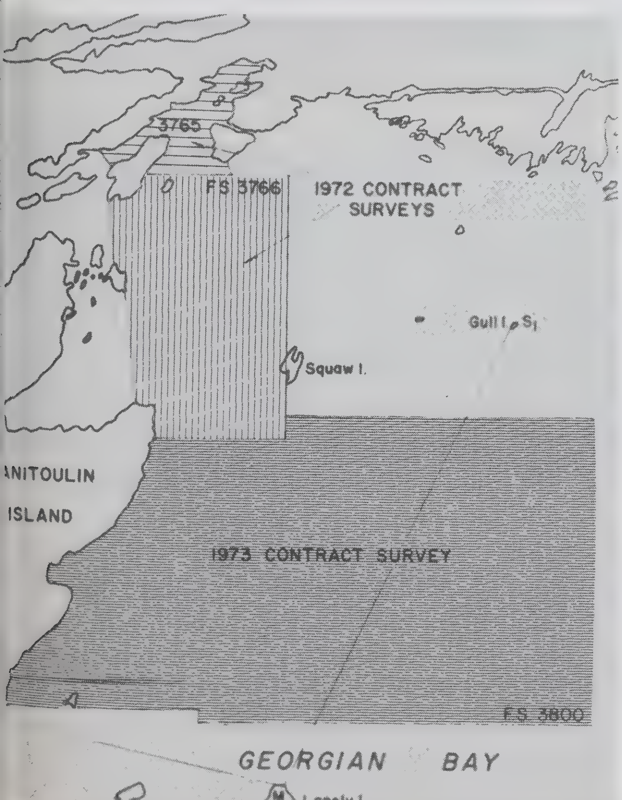
One field sheet was completed which consisted of pproximately half the wharves in Thunder Bay Harbour.

GEORGIAN BAY CONTRACT SURVEY

The Science Council of Canada has recommended that here possible, government and university laboratories ontract work to develop technical expertise in private dustry. With this in mind, a survey was conducted for the cond consecutive year, under contract by COMDEV arine and closely monitored by Central Region hydro-aphers. The field sheet has been submitted to this Region d from all indications, the second contract survey was ery successful.

HAMILTON SCOURGE PROJECT

This project was conducted in conjunction with the oyal Ontario Museum. The objective of this detailed rvey was to locate and position two U.S. schooners sunk in 1812. Utilizing the PORTE DAUPHINE and HAAPS, both bathymetric and megnetic data were logged during the survey, a computer-aided analysis made to locate anomalies. Unfortunately, the search did not locate the sunken vessels.



Georgian Bay contract survey field sheet layout.

LOWER ST. LAWRENCE SURVEY

This early summer survey was a continuation of a project started in 1969, with the objective of recharting the Lower St. Lawrence River from Pointe-au-Père to Quebec City, a distance of 133 miles.

The party's second objective of establishing control for the preparation of photogrammetric plots from Crane Island to Quebec City was achieved. This will now provide photogrammetric plots for all remaining hydrography as far as Quebec City.

PORTE DAUPHINE lifts survey launch on the St. Lawrence River Survey.

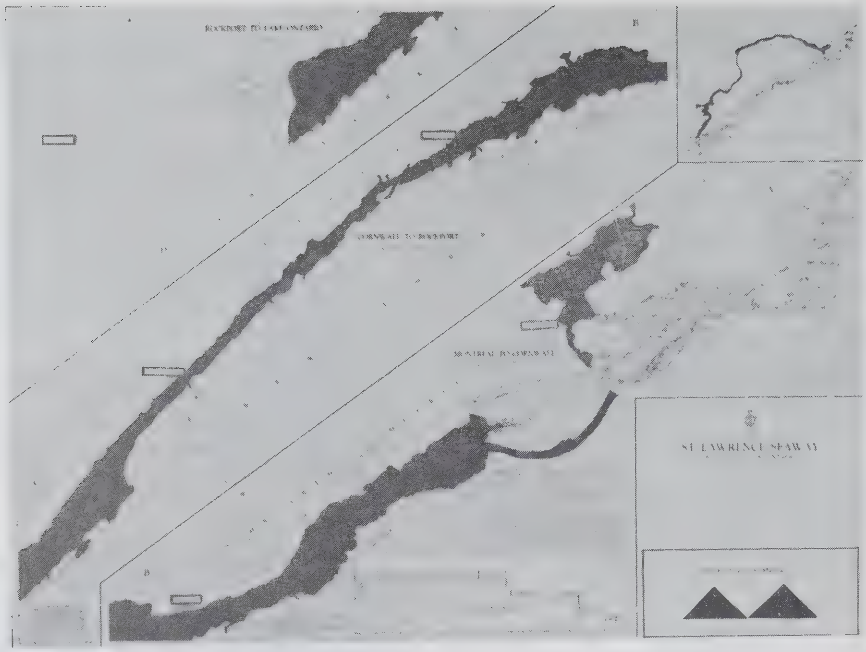
REVISORY SURVEY

This year's Revisory Survey followed the Canadian Hydrographic Service policy of systematically updating all existing charts.

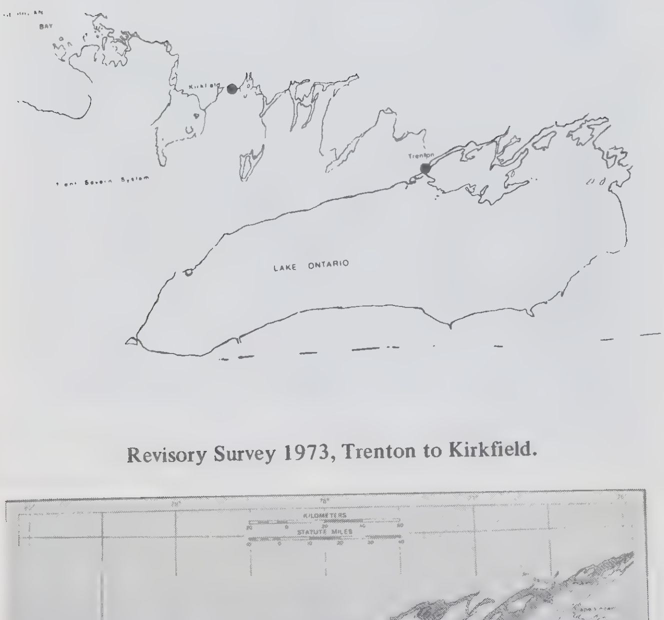
All charts of the Rideau Canal, Lower Ottawa River, The St. Lawrence Seaway from Montreal to Kingston, and the Trent River from Trenton to Balsam Lake, were completed.

NAVIGATIONAL RANGES SURVEY

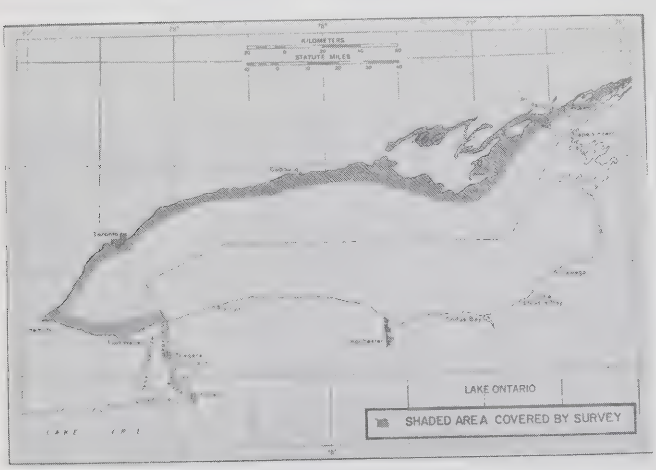
In May, 1968, the Canadian Hydrographic Service accepted responsibility for determining and checking the positions and true bearings of all navigational ranges



St. Lawrence Seaway.



Revisory Survey 1973, Trenton to Kirkfield.



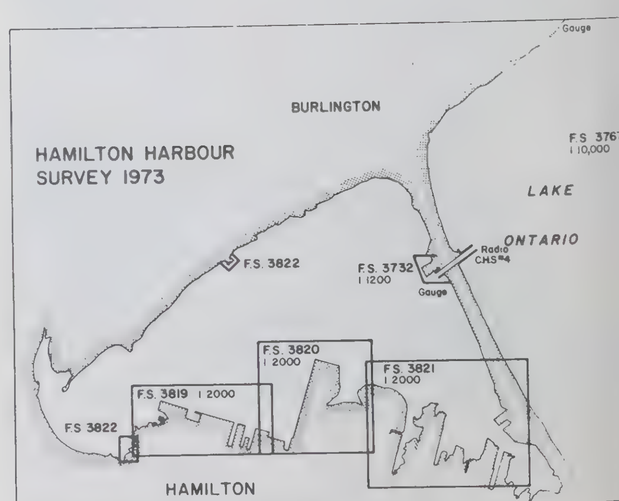
Navigational Range Survey.

established and maintained by Federal Government age
cies and shown on Canadian navigational charts.

Each region assumed responsibility for the ranges their respective areas and Central Region, during 197 sounded and surveyed all ranges from Kingston to Niaga and a set of ranges at Nanticoke on Lake Erie.

LOCAL SURVEYS

During 1973, the Local Surveys party completed i major project; the survey of Hamilton Harbour. Besid Hamilton Harbour, the party completed a variety commitments to assist C.C.I.W. scientific parties in t Hamilton-Toronto area.



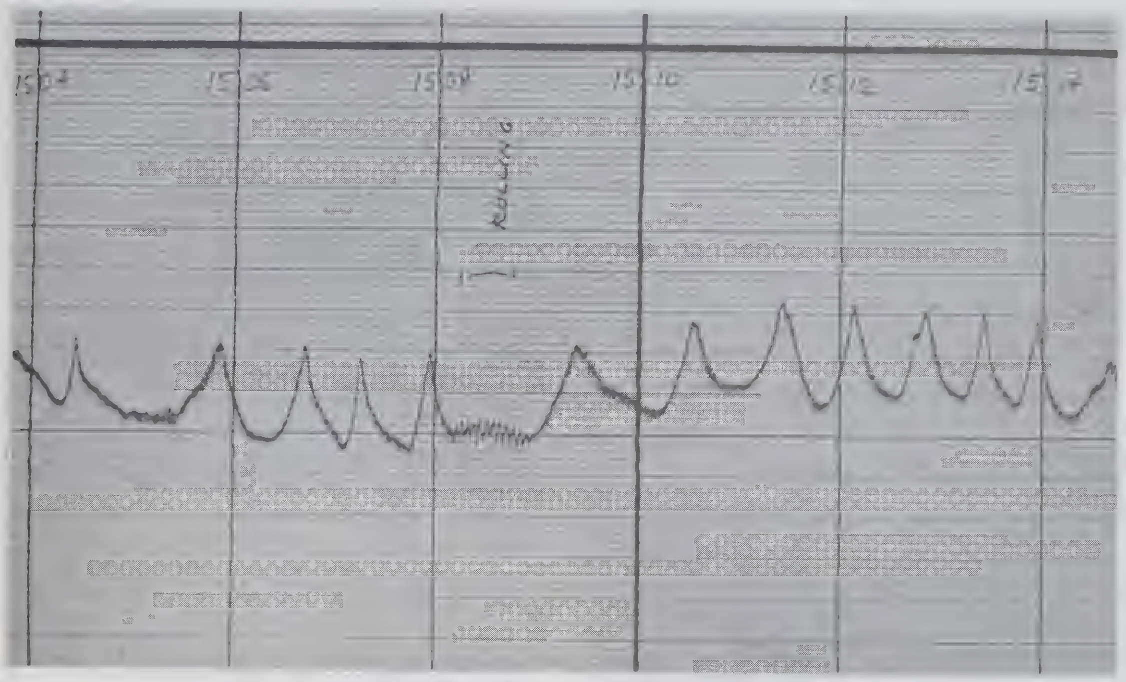
Field sheet layout for Local Surveys.

SAILING DIRECTIONS

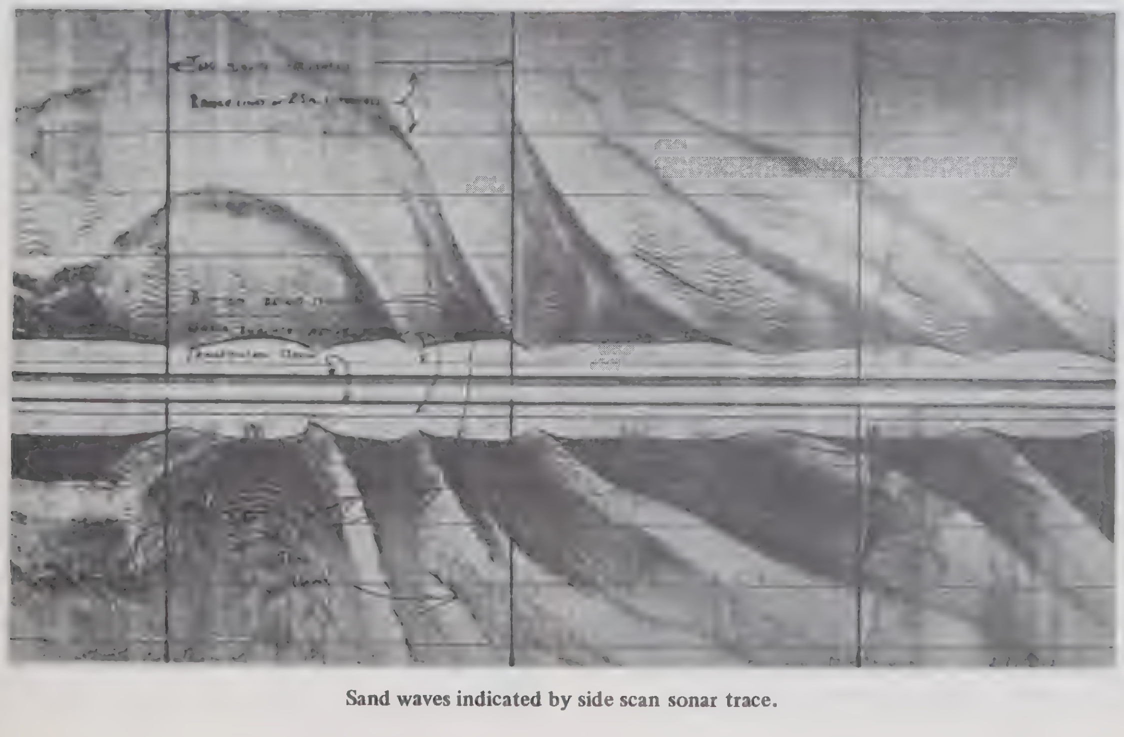
In 1972, it was decided Central Region would produce a volume of sailing directions for small craft operators. During 1973, a Small Craft Volume for the Trent-Severn Waterway was completed and published. In the fall of 1973, field data was collected for additional publications which will cover the Richelieu River, The Lower Ottawa River and the Rideau Canal.

LOWER ST. LAWRENCE SAND WAVE STUDY

This was a short project directed toward the study of sand waves near and in the ship channel between C. Brule and C. Gribane and also near Île d'Orleans.



Sand waves indicated by conventional sounder trace.



Sand waves indicated by side scan sonar trace.

U.S. TECHNICAL EXCHANGE

This was the second year for the four-month technical exchange program between the United States National Ocean Survey and the Marine Sciences Directorate, Central Region, Canadian Hydrographic Service.

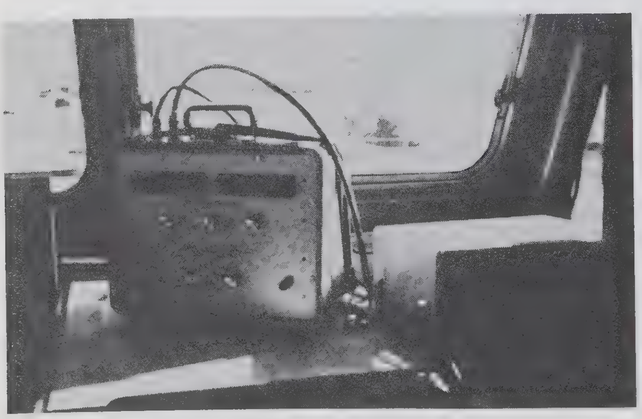
This arrangement was proposed in 1971 by the Director, Lake Survey Center, and the Chief, Central Region and agreed to by Admiral Jones of the National Ocean Survey and Dr. A. Collin of the Department of the Environment.

HYDROGRAPHIC DEVELOPMENT

Side Scan Sonar

During 1973, an analysis of the sonar field data acquired in 1972 was completed and a report was presented at the Canadian Hydrographic Conference. From the promising results obtained, a side scan sonar was purchased and implemented in a field program for 1973.

Lake survey launch LAIDLY.



Trisponder range positioning system display.

Loran-C

The data collected in 1972 with the Internav 101 an the Austron 5,000 system was analysed and the suitabilit of Loran-C for positioning research vessels operating on th Great Lakes was determined. A presentation was made t the Canadian Institute of Surveying Conference outlinir the results of the analysis.

A two-week cruise on Lake Superior was used to te the Internav 101 receiver in an operational environmer The data obtained will be compared to the navigation da obtained by radar fixing.

A demonstration of a low power Loran-C slave static manufactured by Megapulse was conducted. The te showed promising range capability but the overall stabili of the system could not be demonstrated with tl synchronization in the test.

Integrated Navigation System

The plans for a navigation system for CSS LIMNO were developed for use with the International Joi Commission Upper Lakes Reference Studies. The syste has a central computer with inputs from a gyro-compass doppler sonar velocity sensor and a satellite navigati receiver. The system continuously computes the ship position based on the inputs from these sensors a provides steering information to the helmsman as well a digital magnetic tape record of the ship's track position f post-processing. The system requirement has been subm ted to D.S.S. for lease during 1974-75.

Data Logging and Processing System

A second-generation logging system requirement h been prepared and submitted for acquisition early in 197 Three computer-based logging systems utilizing digi cartridge recorders will be acquired for use on hydrograp launches. A computer processing system with a plotter w be used to produce field sheets as with the present HAA system.

Marine Information Centre

During 1973, the Marine Information Centre w relocated and reorganized. The Chart and Map Sales Ou was relocated and integrated with the Public Relations U of C.C.I.W. The centre was renamed the C.C.I.W. Inform tion Centre and will combine Chart and Map Distribut with the general distribution of C.C.I.W. material. T arrangement of tours within the Centre will also be hand through this outlet.

The unit in which Technical Data are retained has b renamed the Hydrographic Data Centre. All field ma scripts, field note books, control information, and sociated data are filed with this unit. Books and Publ tions related to hydrography are retained while ot publications are sent to the C.C.I.W. Library after circ tion.

Central Region's first fully automated field sheet.

AAPS Processing

The Hydrographic Acquisition And Processing System, r HAAPS equipment, appears to have come of age and was sed with great success on the James Bay Survey, Lake St. lair Survey, Lake Ontario, Hamilton-Scourge Project and ne Lower St. Lawrence Sand Wave Study during the 1973 eason.

YPOS Processing

The Hydrographic Processing System was used with easonable success on the Lake Winnipeg Survey during 1973. Slowdowns due to mail service seem to be the major drawback of HYPOS. No further attempts will be made in using this system for support of major surveys.

Gerber 22 Processing

The Gerber 22 plotting system produced numerous lattice sheets for both Central Region and the Atlantic Region; has been used extensively for preparing HYPOS sounding plots and for producing final field sheets for James Bay, Lake St. Clair, Lake Winnipeg and Norwegian Bay.

SHIP DIVISION

A. QUIRK, Regional Marine Superintendent

INTRODUCTION

The Ship Division had another busy year with a heavy emand for ship and launch support for scientific and ydrographic programs. The flexibility and strength of the eet was improved by the addition of ADVENT, a 77′ high peed crew boat and HILDUR, a 106′ research vessel. In ddition several launches were added to the fleet and others ere modified. LIMNOS and MARTIN KARLSEN, which remained on charter, continued to provide strong support for the major scientific programs. In the Arctic the Region was fortunate to have the use of NARWHAL once again and N.B. MCLEAN from the Ministry of Transport.

ADVENT

ADVENT was officially accepted on January 4. This

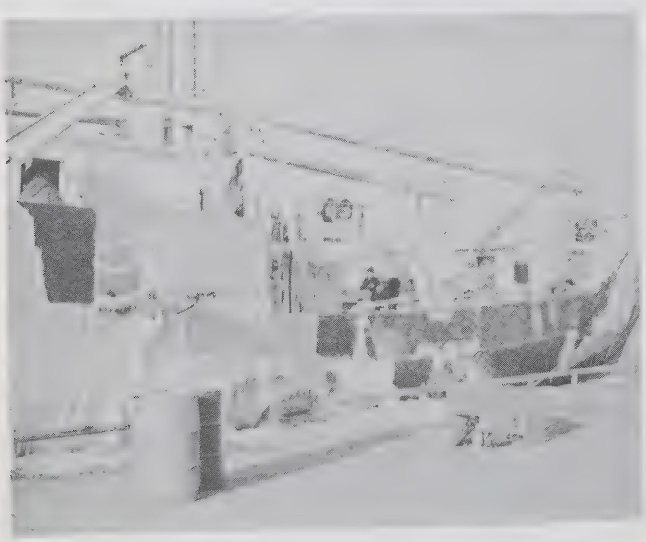
77′ vessel is of the crew boat design used by the oil companies for transporting men and material to offshore oil rigs. It is capable of speeds in excess of 20 knots but has limited accommodation.

Problems were encountered shortly after commissioning because no adequate provisions had been made for wintering. The heating system designed only to heat the accommodation, operated erratically and proved unreliable. Until mid May, outside contractors and Divisional personnel worked on this problem and also installed winches and scientific equipment.

The vessel was evaluated for both scientific sampling and hydrographic surveying. It was found, with respect to the former that the equipping of heavy deck gear and overside towing, seriously reduced the speed. With respect to the latter, the fuel capacity was found to be small and limited the operational range.

During the summer the vessel completed six cruises. Six weeks were spent at Marathon on Lake Superior, six weeks on Lake Erie and several short cruises on Lake Ontario.

The ADVENT.



The MARTIN KARLSEN after a winter cruise.

PORTE DAUPHINE

PORTE DAUPHINE had previously been operated by the Ministry of Transport for the Great Lakes Institute. During the year operational control was transferred to the Marine Sciences Directorate.

The vessel was used for the greater part of the summer in the Lower St. Lawrence River. Initially it was fitted fo hydrographic operations and arrangements made fo hoisting two Botved launches. Due to the poor winch arrangements this proved unsatisfactory. Later the ship wa outfitted again for a tidal current survey but once more th poor deck gear proved something less than efficient. Late in the year PORTE DAUPHINE was used by personne from the Royal Ontario Museum for an archeological searcl for two schooners sunk off the Niagara River in 1813. A spin-off from that operation was a precise hydrographi survey.

LIMNOS

LIMNOS operated without a winter break. During th year it carried out 31 cruises and steamed a total of 24,29 miles. Major repairs were carried out on both Harbou Master units and the port engine removed, disassembled an replaced, while the ship remained afloat. Drydocking, wit all its accompanying frustrations and delays was carried ou in July. However, the five year hull and machiner inspection was completed and the vessel sailed on schedul The only lost time by this vessel during the year was cause by the unavailability of parts for the 5-ton Auston Westo crane that is used for mooring operations.

Experience this year has shown that the vessel unsuited for winter operations in the Great Lakes. Not on do large amounts of ice form on both superstructure ar decks but various underwater parts, particularly the nau log and gears in the Harbour Master units get damaged b the ice.

MARTIN KARLSEN

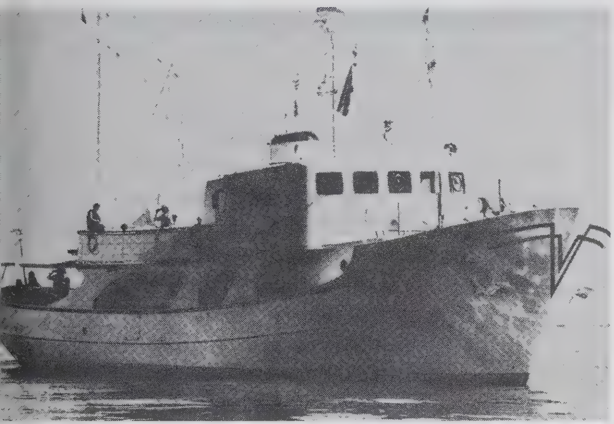
This large chartered vessel completed 21 cruis throughout the Upper and Lower Lakes. This vessel ar LIMNOS provide the major support for scientific prograr in the Great Lakes.

A 20 KW Motor Generator was installed aboard overcome the acute shortage of AC power experienced t previous year. The installation experienced serious vibratic and bearing failures. Vibrometer and clock gauge readin were taken and analysed by Divisional staff. The recor mendations made to the suppliers were successful in curi the problems.

HILDUR

The newly purchased yacht HILDUR was delivered the Centre on December 5, 1973. The vessel, a 106′ sh

ill be used for scientific and hydrographic purposes on the reat Lakes. When new, the HILDUR was employed as a search vessel in the Caribbean, therefore requiring few odifications. After being renamed and outfitted with the uipment necessary to start Scientific and Hydrographic berations, this vessel should prove beneficial to the Centre ıring 1974.



The HILDUR.

LAC ERIE

LAC ERIE, a chartered, converted tug was again used r limnological work in the Lower Lakes making a total of cruises. As an economic measure this vessel was taken f charter in the fall.

NARWHAL

For the second year Central Region was fortunate in ving the use of the Ministry of Transport's light ice-eaker NARWHAL for work in James Bay. This project ıs under way early in July when the C.C.G.S. NARWHAL ıs equipped at Burlington with two major launches, 'URDY and SURGE, and two DEL QUAY dories. Two w engines were installed on the SURGE, and the 'URDY was equipped with two reconditioned engines. l launches were outfitted at Burlington with electronic 'vey equipment and were tested in Hamilton Harbour to ure that the launches and all equipment were in first-rate ndition before being transported to James Bay. Excellent ather in James Bay enabled the survey to be completed October 2. The NARWHAL returned to Halifax where launches and equipment were returned to Burlington for nter overhaul and modification.

N.B. MCLEAN

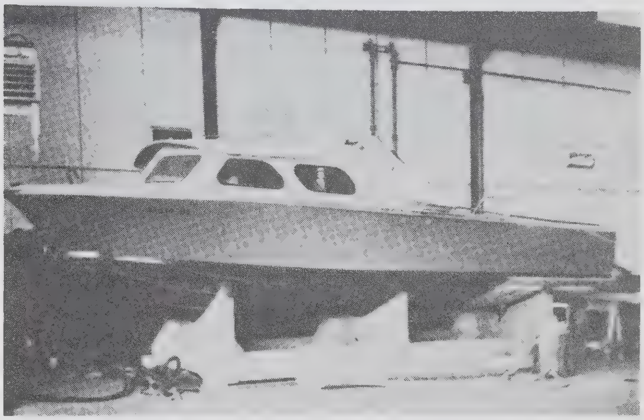
The alteration of Regional boundaries to include ıdson Bay, presented Central Region with one more challenge. With the start of the Chesterfield Inlet Survey in Hudson Bay, another icebreaker, the C.C.G.S. N.B. MCLEAN on loan from M.O.T. was outfitted at Halifax. It was planned to use the launches from the Thunder Bay Survey, loading them aboard N.B. MCLEAN at Churchill. However, due to a railway strike this was not possible. Instead, two landing barges normally carried by N.B. MCLEAN were temporarily outfitted and used as sounding vehicles for this survey.

VESSELS – ENVIRONMENTAL PROTECTION

An oil recovery barge was used at the Centre for testing Oil Contingency equipment for the full season and was finally removed from the program when ice conditions no longer permitted operation here at the base.

LAUNCHES – HYDROGRAPHY

Reconditioning and repair of launches got an early start during the latter part of 1972. This was made possible



Stretched Bertram launch.

Enclosed DEL QUAY dory.

by the early closing of many field surveys and therefore, enabling all launches to be repaired and tested before freeze up. When all launches were tested and found to be in order they were winterized and placed in outside storage. However, on de-winterizing and testing prior to the field season, it was found that most of the work had to be duplicated, particularly the work to the electrical systems. Severe corrosion caused by dampness during winter storage, pointed out a need at the Centre for a dry covered storage area.

VEDETTE and VERITY, the larger class of survey launches, were used for Revisory Surveys on the Trent-Severn Waterway, the St. Lawrence River and the Ottawa River. Some difficulties developed with the V-drive on VERITY during the season. Two launches, the SURGE and STURDY, were used in James Bay, also launches were transported to Lake Winnipeg and the Lower St. Lawrence to continue the Hydrographic Surveys in these areas. Launch support was provided to survey parties on Lake Superior, Lake Huron, Georgian Bay, Lake St. Clair, as well as Lakes Erie and Ontario.

Some interesting changes were made to some of th Bertram class launches. BRUCE was stretched in length b adding an additional 6 feet, making the boat 31 feet overal A Cummins TM 370 diesel engine was installed.

Two modified Bertram Launches were received fror Dartmouth, HYDRO I and HYDRO II, each powered b GM 6V 53 diesel engines.

Work was started on completely overhauling thes boats and installation of single gasoline engines.

SHIP VISITS

In September the Centre was honoured by a visit fro the H.M.C.S. MARGAREE and the BRIGANTIN PATHFINDER. Open House for these vessels was arrange by the Centre followed later by a successful Open Hous for the ships here at Burlington.

RESEARCH AND DEVELOPMENT DIVISION

N. Freeman, A/Head

In order to respond effectively to the Region's increasing involvement in scientific programs on the Great Lakes, St. Lawrence River Estuary, and James Bay, the Research and Development Division (formerly Geotechnology) was officially created on August 15, 1973. Its main program objectives in 1973 were: 1) to provide a descriptive and predictive capability for the tides and currents in the Upper St. Lawrence River Estuary; 2) to provide a marine and estuarine environmental impact assessment of the James Bay Power Project; 3) to provide operational techniques for storm surge forecasting on the Great Lakes; 4) to provide coastal zone management information for the Great Lakes; 5) to provide an erosion, inundation, and property damage assessment resulting from the high water levels on the Great Lakes; 6) to provide survey electronics support to the Hydrographic and Limnological field programs; and 7) to provide tide, current and water level support to Hydrographic charting operations. These programs were formulated into fourteen project areas and were carried out by the four sections: Hydrodynamics, Shore Property Studies, Survey Electronics and Oceanographic Research.

In addition to the above ongoing programs, new program areas in 1974 will include: 1) the provision of information on current predictability and spatiality in the St. Clair-Detroit Rivers for "Operation Preparedness", 2) the development of photogrammetry techniques for erosion studies, 3) increased instrument development capability in Survey Electronics.

HYDRODYNAMICS SECTION

The section evolved out of the Hydrographic, Tides and Water Levels Unit to become the main group for th planning, collection, analysis, and interpretation of currer and water level data, principally on marine waters, for th description and prediction of hydrodynamic processes.

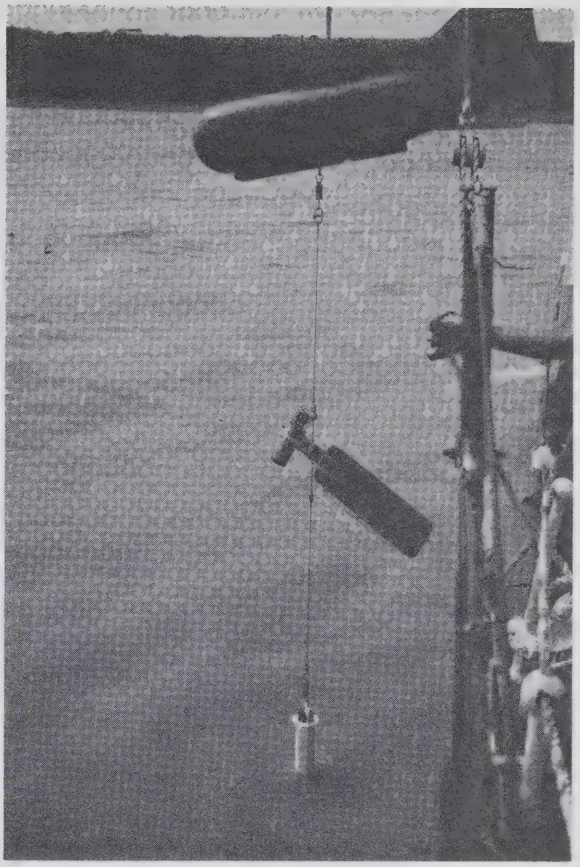
All Hydrographic surveys received support on a on-going basis for: sounding datums, field sheet checkin bench mark information, tide gauging, daily water lev retrievals, automated sounding reductions, and co-tid charts. Some 30 monthly water level records were digitize for submission for publication and for scientific spectr analysis by physical limnologists. A weekly water lev bulletin, indicating present levels, as well as trends fro past and future levels, was produced for Public Relatio and a few external organizations. The sounding datum fo Playgreen Lake was reviewed in light of new data and w retained. A sounding datum for Lake Winnipeg was als calculated. The Killarney sounding datum was revised base upon a one month water level transfer from Little Curren The Bass Engineering *in situ* tide gauge was successful deployed and recovered off Cape Henrietta Maria by th James Bay Hydrographic Survey party. Positioning tec niques using Motorola R.P.S. were developed for tracking meter drogues. Our staff took part in the development of water levels display for the Toronto Boat Show and were c hand to answer questions regarding the high lake levels. December, the Hydrographic support function was transferr back to the Tides and Water Levels unit, Hydrograph

The main objectives of the St. Lawrence River Hydr dynamics Pilot Study were: 1) to gain experience in layi and retrieving current meter strings in complex tidal wate 2) to evaluate the reliability of the 1939 Tidal Curre Atlas and thus the need for a long-term study. Ope tionally, the program consisted of two phases: (a) a sin

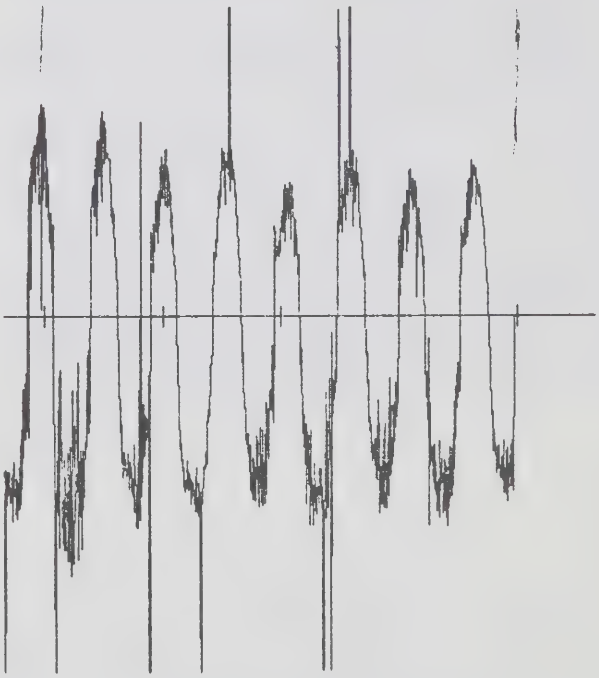
ixed current station and portable current observations off irande Isle in Kamouraska Basin, carried out jointly by I.G. Acres, Technical Operations, and Marine Sciences in Aay; (b) a number of fixed current stations, portable urrent observations and drogue tracks off Isle d'Orleans, arried out by this section in August. The first location rovided current data in a two-layered region, and the second rovided data in a well-mixed region at the boundary of I.R.C.'s two-dimensional numerical model. In the field peration, some difficulties were experienced with the istrumentation, the newly developed surface referenced nooring, the stability of the tower, and the maneuverbility of the deployment vessel. Preliminary analysis of the irande Isle data indicates that the tidal flow in the reshwater layer, between 15 to 30 meters thick, leads the ower saltwater layer by approximately 3 hours and a ignificant cross-channel flow exists. While the Isle 'Orleans data is still in the analysis stage, some immediate bservations can be made: 1) the tidal current, specifically he turning of the tide, is significantly affected by wind ction, thus making precise prediction difficult in these hallow areas; 2) some discrepancies with the Atlas do exist equiring further investigation.

Early in the year, various instruments were evaluated y contacting users and reviewing the appropriate National ceanographic Instrument Centre, Fact Sheets, resulting in he purchase of 6 Aanderaa RCM-4 current meters, 3 Lewis de gauges, 3 Interocean acoustic command releases. Three ommercially available current meters were tested in a ontrolled magnetic field to ascertain their usefulness close the magnetic north pole in Canada's central Arctic. A urface referenced mooring system, which maintains the urrent meter at a fixed distance from the surface at all ages of the tide, was developed and tested on the St. awrence River Survey. It was found that insufficient eight caused the anchors to move together and a jammed ulley caused the steel wire to chafe, resulting in the whole ystem coming adrift (the instrumentation was recovered). uring the year, discussions involving Atlantic, Central and acific Regions, M.S.D. and I.W.D., Burlington, were held ascertain the feasibility of establishing a national current alibration facility using the Hydraulics and Engineering apabilities at C.C.I.W. A physical model depicting waves reaking on a beach and marine structures was built by the aff in order to dramatize, at the Toronto Boat Show, the osive and inundative effects of the recent high lake levels. hree excellent symposiums on instrumentation were atnded by our staff: 1) I.S.A. Marine Science Symposium at ocoa Beach, Florida; 2) Third Annual Buoy Technology orkshop at Wood's Hole; 3) Tides and Water Levels orkshop at Vistoria, B.C.

Numerous computer programs for the data translation onstituent and spectral analyses, coordinate plotting, alculation of oceanographic parameters, solution of simulneous equations, etc., were written, modified and/or onverted to the CDC-3100. A method for fitting a sum of osine terms was developed, whose frequencies are known, a curve, by method of least squares. The Plessey anslator program was significantly modified to handle the



Current meter mooring system showing subsurface float, current meter and acoustic release.



Current observation over a 4-day period.

Aanderaa tapes. Presently we are in the process of developing a mathematical technique to decipher tidal information from the Bass tide gauge.

A two-dimensional numerical hydrodynamical model of Lake Huron, developed by the section, demonstrated that sub-synoptic scale meteorological processes can generate a large portion of the storm surge set-up. A two-dimensional numerical tidal propagation model is presently being developed. A numerical technique to model the response of the surface-referenced mooring system to various static and dynamic loading conditions has been developed by a cooperative student at University of Waterloo in consultation with staff in this section. A statistical model for sloping sounding datum calculations was also developed.

The increased potential in recent years for inundation of low lying shoreline by short-term water level fluctuations, necessitated the joint (A.E.S., M.S.D., Ontario Hydro, I.W.D.) implementation of a storm surge warning system for Lakes Erie and St. Clair. The predictive model for Lake Erie was taken from Ontario Hydro, while our staff prepared a preliminary statistical method for Lake St. Clair. Late in August, a one year contract (shared with I.W.D.) was let to a research scientist to develop operational techniques for storm surge forecasting on all the Great Lakes.

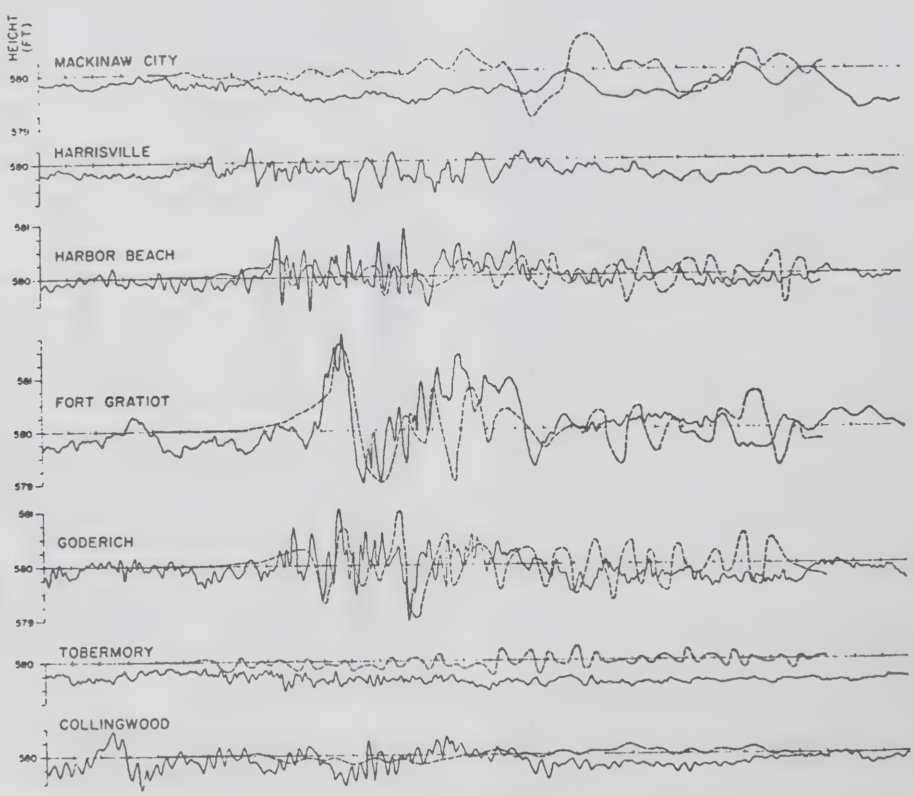
Future projects in 1974 will include the developmen of a two-dimensional model of the St. Clair-Detroit Rive system, the measurement of currents in this system, th analysis and interpretation of the St. Lawrence Rive current data, and the continuation of on-going projects Also the surface-reference mooring system with appropriat modifications will undergo extensive testing in 1974, in th Niagara River, and will be instrumented to evaluate th response of the mooring system and current meter to suc external forcings as line strumming and surface wave action

SURVEY ELECTRONICS

As usual the Survey Electronics group was very bus again this year. The loss of key personnel to other region and other departments resulted in the appearance of severa new faces in the shop.

Technicians were in the field with survey parties o James Bay, on Lake Winnipeg, on Lake St. Clair, on th Polar Shelf project, aboard the BAFFIN in the Caribbea and with the St. Lawrence Hydrodynamics Pilot Study. I addition we supported the launches and projects based a and from the Canada Centre for Inland Waters.

Again this year, the James Bay Survey was one of th most demanding as far as the Electronics Shop wa



Computed and observed water levels (squall scale forcing), Lake Huron.

concerned. In addition to outfitting the launches with HAAPS equipment, all systems including the Minifix were set up and field tested at Burlington prior to proceeding north. The survey utilized Ross Sounders, three HAAPS systems and a shipboard computer processing system. The long range Minifix system was again employed successfully.

The Lake Winnipeg Survey also utilized a high power Minifix system. In fact as a consequence of the high power and resulting interference with the Provincial Forestry Service the frequency of the Minifix Chain will be changed for the 1974 operation.

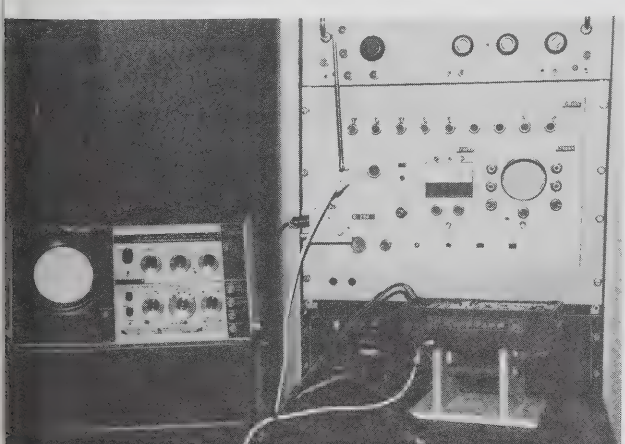
We were again involved in the Polar Continental Shelf Program with a technician participating in the full survey. In addition, considerable time was spent outfitting the helicopters before they went north. The survey utilized two RPS systems and Edo Sounders. As a result of the extreme cold, several novel equipment problems were encountered.

Support was also given to an automatic HAAPS system survey on Lake St. Clair in conjunction with the Motorola RPS system.

The choicest field assignment this past year was Mr. Smith's three-month assignment to the BAFFIN on her Caribbean cruise. Mr. Smith and a technician from the east coast were responsible for maintaining the electronic equipment used on the training program.

Again this year, but for the final time, a technician was seconded to the Hydrographic Development Section. Hydrographic Development is now defining their own Electronic Technologist position. The seconding of technicians from the Electronics Shop has been a very valuable undertaking in that it has brought one technician a year up-to-date with what Hydrographic Development is doing and thus knowledgeable on the new systems to be introduced to field operations. It is hoped to continue close involvement with Hydrographic Development in the form of short-term assignment of technicians to development work.

Due to the ever increasing complexity of the equipment being utilized, the Electronics Section has spent a considerable amount of time on staff training again this year. This included courses on Motorola RPS, Tellurometers, HAAPS system, Minifix and computers.



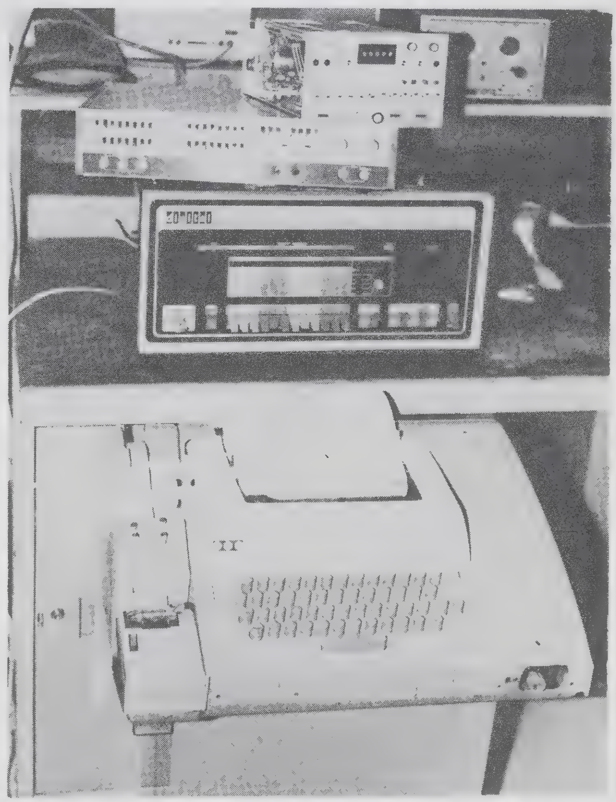
VHF test equipment.

During the year the facilities were upgraded for servicing our VHF radio telephones, of which we now have more than one hundred.

We also became responsible for service and maintenance of the HAAPS system and for three Digital Equipment Corporation computers. This has also necessitated the purchase of new test equipment and need for additional training. Additionally, we acquired an extremely stable standard frequency signal generator for calibration purposes in the shop.

During the summer a Career Oriented Summer Student was employed and as a result of his excellent performance he will be hired in the spring.

Other areas of present involvement, in addition to the yearly overhaul, include preparation for trials and evaluations to extend the range of the Minifix system, modification to the Digital Coupling units for the HAAPS system and modifications to the RPS system in order to reduce the interference from marine radar.



Computer, teletype and associated test equipment.

SHORE PROPERTY STUDIES

The year 1973 will be remembered as a year of severe damage to shoreline property on the Great Lakes. Record erosion, inundation and structural damage resulted from fall and spring storms superimposed upon the already existing high water levels. This condition created an

Lake Ontario – aftermath of spring storms, 1973.

unusually heavy work load for the section. In order to record the extent of the damage an immediate inventory of changes was necessary. To accomplish this in the shortest time possible following the storms, a low altitude airborne survey was conducted. The results of this survey led to the agreement between Canada and Ontario Governments to undertake a more detailed evaluation of the damages along the erodible shoreline of the Great Lakes.

Shore Property Studies Section was charged with the direction and implementation of this task, which was comprised of the following projects:

1. Stage Damage

The important aspect of this survey was to colle sufficient information as to the extent of the dama caused to individual properties along the 800 miles of t erodible shoreline of Lakes Ontario, Erie, St. Clair and t southern portion of Huron and Georgian Bay and th connecting rivers.

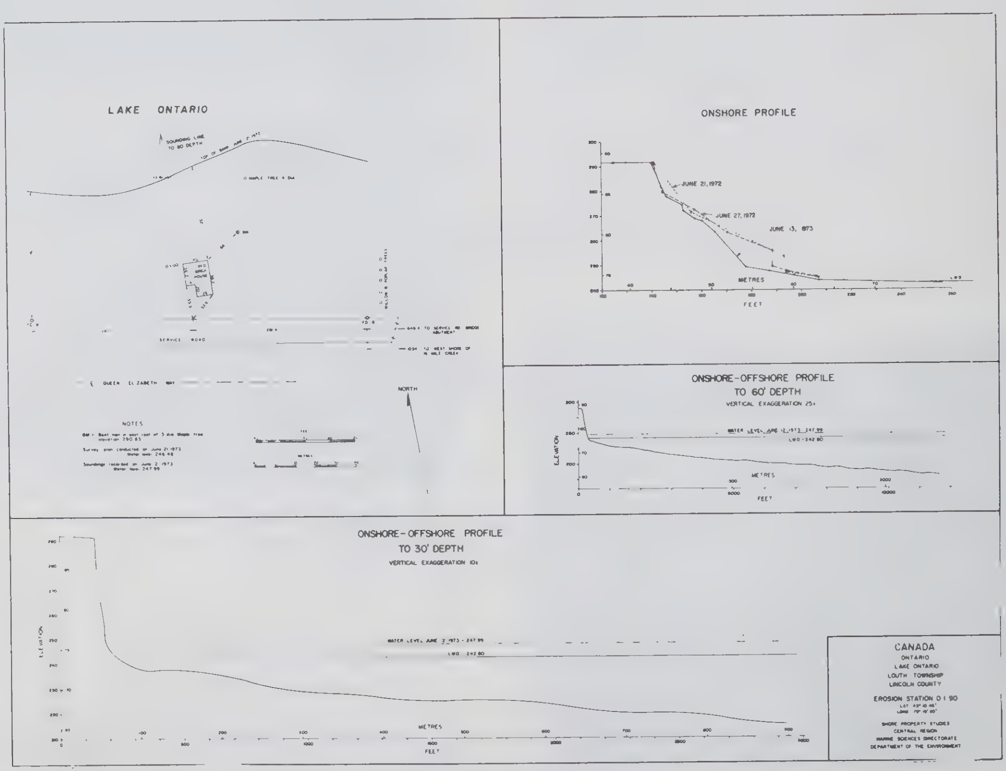
2. Erosion

The ongoing program of reprofiling the subaerial a subaqueous shore zone of 50 previously established erosi stations throughout the Great Lakes System was extend to include the addition of 100 or so new stations to co the total erodible shoreline.

This data will enable in-depth analysis of the amou of sediment contributed to the lake bottom by offsh erosion, maximum depth at which erosion occurs, t movement of sediment in an offshore direction and a rates of erosion to be related to varying lake le conditions. The recorded periodic changes are shown master profile sheets, indicating location plan and prof with onshore and offshore features.

3. Aerial Photography

To delineate peak high water mark, ground controll aerial photography of the erodible shoreline was complet in early June. The photography, taken at a true altitude



Master profile sheet.

,000 feet above mean sea level, shows land detail to a one-
le width along the entire shoreline from the head of the
. Lawrence River through to Georgian Bay.

This photography will be used in the production of a
astal Zone Atlas consisting of master strip maps on a
ale of 1:10,000, showing 3-meter contour lines, shoreline
ysical characteristics, land use, ownership, present struc-
res, areas of erosion, inundation and potential damage,
:. Also, the comparative analysis of aerial photography —
d, recent and new, in terms of shoreline changes due to
omorphic processes (recession and accretion) is being
nducted jointly with L.R.D., results of which will be
corporated into a final map of erosion rates.

Property Values

In cooperation with the Social Sciences Research
ction, a shoreline property inventory of ownership, value
d use of land and its improvement, is being compiled from
essment rolls of Ontario Regional Assessment offices
m Ontario/Quebec border on the east to the Ontario/
nnesota border at the head of Lake Superior on the west.

This inventory will provide the background informa-
n necessary in the evaluation of the extent of shoreline
mage. For purposes of facilitating data retrieval a
mputer data base and coding design has been developed.
e capability for updating has also been incorporated in
program design so that information stored there will
vays be of a current nature.

Technical Report

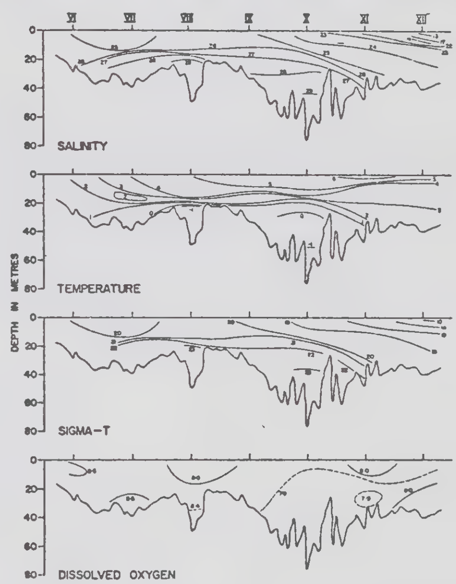
The end of the 73/74 fiscal year will see the emergence
a preliminary report containing information on past and
sent shoreline conditions, which will lead to recom-
ndations on waterfront planning.

In August a research contract for photogrammetric
iff surveying and mapping for Great Lakes shoreline was
arded to Laval University, to develop aerial photo-
mmetry procedures to reduce the compilation time and
sts, when compared with classical ground surveying and
pping. In 1974, additional projects are envisaged as a
ult of the section's representation on the Technical
mmittee of Task D of the I.J.C. Land Drainage Ref-
nce Group.

OCEANOGRAPHIC RESEARCH SECTION

In order to provide basic research backup for the
vision's programs, this section was created during re-
ganization, and staffing of a research scientist position to
d the section, is still in progress. However, throughout
past year, staff from the Hydrodynamics section and
m Hydrography undertook oceanographic field surveys.

The 1973 program consisted basically of reoccupying,
the beginning of August and end of September, the
teen stations of the 1972 survey. These stations were
ated on two latitudinal sections in the northern half of
Bay and two longitudinal sections off La Grande
vière. A total of 32 continuous salinity, temperature and



Above: Contours produced from data obtained from Knudsen Water Sampling Bottle.
Below: Knudsen Sampling Bottle being removed.

depth profiles, 143 discrete salinity, and dissolved oxygen samples, 41 bottom samples, 41 mechanical BT casts and 32 vertical plankton tows were taken. The data is presently being analysed to determine heat and water mass budgets.

A program of through-the-ice physical oceanographic measurements off La Grande Rivière is being carried out this winter and will permit evaluation of the extent of the fresh water plume under ice cover and its effect on ice growth and thermohaline circulation. At the mouth of the La Grande Rivière, current, salinity, and temperature measurements were taken over a 13-hour tidal cycle, with four additional stations occupied up river, at three different stages of the tidal cycle. These data will be

used for planning future programs to study the estuarine dynamics.

ADMINISTRATION

A.W. Appleby, Regional Administrative Officer

During 1973, the Administrative Support Division provided services to three major operating Divisions as follows:

(1) Hydrographic Survey Division with 13 Field Party Accounts.
(2) Research & Development Division with 2 Field Party Accounts including a number of subparties surveying shore property damage on the Great Lakes.
(3) Ships Division providing Ship and Launch support to all Hydrographic Surveys, Hydrodynamics Programs and Scientific Support to CCIW programs with 12 field accounts.

PERSONNEL

The Central Region personnel office retained its staffing, pay and benefits duties throughout the year with some assistance provided by the Ontario Area Personnel Office located at CCIW, Burlington. No personnel files have been transferred from MSD Ottawa as anticipated, and therefore all personnel actions continue to be coordinated by Administrative Services. A total of 162 man-years accounted for 184 staffing actions as follows:

FTC	15 employees
Term	53 employees
Ships Crew Seasonal	73 employees
Career & Co-op Students	36 employees
Contract	7 employees

Peak staff level reached 225 during the summer of 1973.

Classification was active with approximately 88 positions submitted for review or reclassification.

While the local Ontario Area Personnel office at Burlington is understaffed, Central Region will continue to provide much of the interface workload for some time into 1974.

ACCOUNTS

Three accounts staff members catered to a budget of 4M, accounting for 27 field party account activities throughout central Canada and the Arctic. During the 1974 calendar year, 2,600 supplier invoice accounts were processed to RSO for payment.

Key members of the accounts staff won promotion transfers during the period for a 1000 batting average.

Roughly 20,000 photocopies of invoices, purchase orders and other audit documents were passed to M[illegible] Headquarters; a record that is hoped can be diminished[illegible] the future.

SUPPLY SERVICES

A central procurement and supply service consisting[illegible] 6 staff members maintain field support to all areas of [illegible] region.

Inventories hold at about 6,000 accountable line ite[illegible] with stock values reaching $14M.

The scope of 1974 procurement, valued at 1.6M, i[illegible] follows:

750 Purchase Requisitions	–	$1,381,[illegible]
300 Standing Offer Purchases	–	155,[illegible]
508 Memo Orders	–	53,[illegible]
		1,589,[illegible]

MOBILE EQUIPMENT

The regional mobile fleet consists of approximately[illegible] vehicles ranging from station wagons and travelalls, to [illegible] ton trucks; 40 boat haul trailers and 15 workshop, li[illegible] and office trailers. Additionally, 5 vehicles were leased[illegible] meet operational needs.

All equipment was mobile in the Manitoba, Ont[illegible] and Quebec provinces throughout the operational seas[illegible] All maintenance is conducted through contract.

During 1973, Central Region vehicles travelled 221,[illegible] miles. Five accidents were recorded costing $1,708[illegible] repair. Main cause factors were:

(1) speed too fast for conditions
(2) inattention

Although a degree of negligence was exhibited in [illegible] of the five accidents, it was judged to be of a minor na[illegible] and none of the drivers were assessed damages.

During the month of April, 25 user drivers attend[illegible] Defensive Driving Course conducted at the CCIW by[illegible] Ontario Safety League instructor.

SAFETY

Management and Staff have responded favourabl[illegible] the increasing emphasis on Safety procedures and [illegible] grammes outlined in recent departmental minutes [illegible] memoranda.

CARTOGRAPHY

The Cartographic Unit of the Marine Sciences D[illegible] torate, Central Region, comprising of Mr. J. Elliott, H[illegible] and Mr. S. Holm, technical assistant, was involve[illegible] increasingly diversified assignments during 1973.

Shore property plan and profile drawings for the Lake rie erosion stations were completed during the summer nd work is now progressing on the Lake Ontario stations. artographic support was given in the preparation of a umber of technical data reports. This consisted of the rawing of graphs, illustrations and the silk screening of the eport covers. During 1973, in-house production of 35 mm lides and photo-enlarging was commenced, resulting in ubstantial savings. Assistance was given to the Electronics Unit in the production of electronic circuit boards. Utilizing the photo-typesetter, the unit is preparing formats of the literature to be used for the Canadian Hydrographic Conference in March, 1974. The Cartographic Unit continues to coordinate the reprographic and photographic needs of the Central Region, purchase drafting materials and instruments as required by the hydrographers and maintaining a slide library.

Office of the Senior Scientist

)ffice of the Senior Scientist

The Office of the Senior Scientist, CCIW, established ı 1973, carries responsibilities for ensuring coordination of mnological and related research programming between ervices, for assessing research developments and results in pecific areas, for consultation with scientists on projects, nd for undertaking research of a synthesizing nature. Also, ne Senior Scientist provides advice on, and assists the irector of CCIW in national and international scientific ogramme developments.

To this end, the Senior Scientist acts as Chairman of ne Scientific Council for Coordination. The office com-ises the Secretariat to the Council and to programme view boards and keeps liaison with national and inter-ational committees.

The membership of the Scientific Council is composed Chiefs of Research Divisions and research units of all ervices, plus working scientists named by the CCIW ientific community. The Council is responsible for iden-fying for managers, needs and opportunities for closer oordination of projects and programmes, for developing ng-term research objectives and strategies, for advising CIW managers of *scientific* merits and priorities of oposed projects and programmes and for periodically viewing progress of scientific programmes, advising on anges or possible termination.

During 1973, the basic concepts of the Council have en developed and activities have been initiated in several eas, including project forecast and progress review. With e increasing number of research programmes and projects, hich presently number some 250 individual projects per ar, it has become necessary to revise the categories of ogrammes and to define their interrelationships. More ncise programming and long-term planning has been itiated in a few areas through establishing several task oups with continuing responsibility to the Council.

TOXIC SUBSTANCES GROUP

This group comprises some 25 scientists drawn from ıkes Research Division, Social Science Research, Water uality Division, the Great Lakes Biolimnology Labora-ry, the Environmental Protection Service and the En-ronmental Quality Coordination Unit. It played an active le in preparing background information, reports and commendations on presently or potentially hazardous bstances in the aquatic environment, their effects, xicity and distribution.

The Toxic Substances Group has met fairly regularly d has to date, prepared specific reports on polychlorinated biphenyls (PCB's) and phthalic acid esters with recommendations for specific studies regarding these contaminants. Other subjects which have been dealt with are toxic substances, with respect to water quality criteria and objectives as specified in the Canada-US Agreement on the Great Lakes, and chlorinated hydrocarbons in the lakes environment.

PHOSPHORUS LIMNOLOGY GROUP

Membership of this group is mainly drawn from Lakes Research Division, the Great Lakes Biolimnology Laboratory, Hydraulics Division, the Environmental Protection Service and Scientific Support Division. A preliminary report outlining areas in which further research is needed was presented to the Scientific Council. Continuing attention is given to nature and amounts of phosphorus inputs into the Great Lakes and movement of phosphorus within the lakes.

NEARSHORE PROCESSES TASK GROUP

Membership of this group is drawn from Physical Limnology, Geolimnology, Hydraulics, Chemical Limnology, Biolimnology and Remote Sensing. The objective of this group was to elucidate, on an interdisciplinary basis, research needs for assessing the complex interactions between shoreline and lake bottom, waves, biota and man-induced stresses in the nearshore zone. A preliminary report to the Scientific Council has been submitted outlining areas for interdisciplinary studies. From this grew the formulation of several joint projects by scientists in different disciplines. A nearshore experimental site has been established by physicists, geologists and hydraulicists at Hamilton Beach to investigate waves and sediment dynamics close to shore.

Further discussions are continuing on definition of inshore versus offshore processes and regions in order to find a better conceptual basis on which future programming can be built.

INSTRUMENTATION DEVELOPMENT TASK GROUP

The scope of this task group is to anticipate major instrumentation needs for environmental application rather than to react to requests for instrument manufacturing for specific purposes. The need to develop new technology and

apply advanced techniques is particularly felt in regard to monitoring and surveillance to minimize costs of such programmes. The task force has begun studying feasibility of producing automated water quality monitoring packages, sensors already available or in the stage of anticipated applicability, automated devices for sampling, application of optical principles, etc. Expertise is drawn from Scientific Support Division, Scientific Operations Division and all research units involved in field programming.

ANALYTICAL METHODS TASK GROUP

This group provides a forum for coordinating of development of analytical techniques in water chemistry, sediment geochemistry, biology, etc. at CCIW and recommends priorities. Input originates with all components requiring analytical methods, and from task groups such as Toxic Substances Group. The Analytical Methods Task Group operates on an *ad hoc* basis rather than on one of continuing conceptual review. During the year, a number of requests for methods development channeled through this group have been forwarded to the Analytical Methods Research Section for project initiation, in particular, automated methods for ATP, chlorophyll *a* and phthalic acid esters.

In addition to these activities, the Senior Scientist was involved in several national and international Committees and Boards providing input to the IJC, Great Lakes Water Quality Board (member), the IJC Research Advisory Board (Chairman of the Standing Committee on Eutrophication), the NRC Committee on Water. For the latter, a report on the present state of eutrophication research regarding the relationship between phosphorus input and trophic state has been prepared by his office.

In international activities, the Senior Scientist has participated in preparation of an OECD report on thermal discharges. He has chaired the Technical Bureau of the OECD Programme on Eutrophication Monitoring and Measurements and, in collaboration with federal, provincial and EPA staff, has initiated the coordination of the North American Project. Further, he has been actively involved in arranging the International Congress of Limnology to be held in Winnipeg, August, 1974.

Environmental Quality Coordination Unit

:nvironmental Quality Coordination Unit

The Environmental Quality Coordination Unit (EQCU) ; responsible for the integration and/or coordination of esearch results from components of CCIW with research esults produced by other groups in a form suitable for use y federal, provincial and municipal water managers and to ssist in ministerial and departmental policy decisions. :QCU provides technical secretariat support to all IJC ireat Lakes Boards and Reference Groups related to Great .akes water quality and provides the Chairman of the Vater Quality Board's Implementation Committee. Co-rdination is provided for CCIW research and surveillance ctivities called for under the Canada-U.S. Agreement and or the International Joint Commission's two new water uality References. Assistance is provided to the Director in ischarging responsibilities as Technical Committee Chair-nan under the Canada-Ontario Agreement. The coordina-on of CCIW research contracts of a multi-disciplinary ature is a continuing function.

CANADA-UNITED STATES AGREEMENT

EQCU was actively involved in the Canadian im-lementation activities associated with the Canada-United tates Agreement on Great Lakes Water Quality signed in pril 1972: through support to the Director, CCIW, who vas named to the Interdepartmental Committee on Water's ubcommittee concerned with implementation; and hrough participation in the development of submissions to reasury Board for resources to carry out the various tudies and other activities required by the Agreement and ne associated "Make or Buy" analysis.

EQCU staff were involved in the semi-annual "stock-aking" meetings held by the two countries to assess evelopments with respect to the terms of the Agreement.

EQCU has for a number of years been extensively ivolved in IJC activities. With the signing of the Great akes Water Quality Agreement, additional activities were enerated with a number of personnel from CCIW and lland Waters Directorate, Ottawa, being named to various oards and Reference Groups which were established. QCU is providing the technical secretariat for the Cana-ian Chairmen of the Great Lakes Water Quality Board, the esearch Advisory Board, the Land Drainage Reference iroup and the Upper Lakes Reference Group.

EQCU participated in the preparation of annual and emi-annual reports for the various Boards and Groups to ne International Joint Commission, and in the planning nd drafting of study plans for the Upper Lakes and Land rainage Reference Groups, as well as assisting in the development of submissions to Treasury Board for resources to carry out the various studies called for in these plans.

A major activity was assisting in the preparation of the Great Lakes Water Quality Board's first annual report on Great Lakes water quality, a 300-page document prepared for the International Joint Commission and submitted in April 1973.

Assistance was provided in the preparation of a report to the International Joint Commission on the extent of phosphorus loadings and recommended gross reductions in phosphorus loadings to the Upper Great Lakes. This report was subsequently adopted by the two countries.

CANADA-ONTARIO AGREEMENT

EQCU continued its coordinating role in support of the Canada-Ontario Agreement on Great Lakes Water Quality. This federal/provincial agreement provides a basis for Canada's participation in the Canada-U.S. Agreement. The Unit participated in the activities of the Technical Committee's Subcommittees on Technology Transfer and the Land Disposal of Sludge. Other principle activities concerned the administration and review of external contracts awarded under the provision of this Agreement, the preparation of detailed financial statements and the development of publication policies for Canada-Ontario Agreement reports. Staff also participated in the planning of two Phosphorus Removal Design Seminars which were attended by personnel from industry, universities and local, regional and national governments. These activities help ensure that the information produced both by the in-house (Canada and Ontario) and external research activities is effectively put into practice both by government agencies and by the private sector, particularly in the design of wastewater treatment facilities required as a result of the Agreement.

ENVIRONMENTAL CONTAMINANTS

EQCU participated in several projects related to the control of environmental contaminants. Staff assisted in defining objectives and developing protocols related to research in this area. The pesticide and organochlorine surveys of the lower Great Lakes, initiated in the previous year and coordinated by the EQCU, were completed. A report documenting the levels of these contaminants in water, plankton and fish was prepared. A report on

polychlorinated biphenyls (PCB's — in the Great Lakes environment, prepared for the IJC Water Quality Board the previous year, was up-dated. Staff members drafted Canada's reply to a questionnaire from the Organization for Economic Cooperation and Development (OECD) on the distribution of phenols in the Canadian aquatic environment, the extent of the problem, methods of treatment and economics of control.

The detection of asbestos-like particles in Lake Superior and in the Duluth water supply resulted in the initiation of considerable action. Background information was assembled to evaluate the significance of this contaminant, particularly as it pertains to Canadian waters. Evidence gathered to date indicates that Canadian population centres on Lake Superior (notably Thunder Bay) have no higher levels of asbestos in the water supply than most Canadian cities such as Toronto or Ottawa. Also, the asbestos found in the Thunder Bay water supply is a different kind from that found in Duluth, Minnesota. Meetings were called involving government and university scientists to review the implications of the available data. A sampling programme was initiated and close coordination and liaison was maintained by EQCU with U.S. Environmental Protection Agency officials.

The Unit prepared a preliminary assessment of the effects on water quality of the 1970 detergent reformulation legislation. A significant reduction in phosphorus loads to waste treatment plants was demonstrated. Thus the loading to the environment has been reduced. It has not yet been possible to demonstrate an effect on the Great Lakes themselves due to their vast size and large year-to-year variability.

The Unit continued its support of the national NTA monitoring programme through liaison with industry and by scientific assessment of the results of the monitor. The almost total absence of NTA in water supplies and the continued low level in surface and ground waters in the face of large increases in NTA usage in detergent formulation clearly indicates that NTA biodegrades rapidly and completely in the natural environment.

EQCU continued to represent CCIW on a number of interdepartmental committees, carried out a number of international functions pertinent to the work at CCIW, and carried out extensive information programmes through the giving of talks and papers at a number of conferences and symposia throughout the year.

Public Relations Unit

Public Relations Unit

In 1973, there were several new initiatives in the entre's public relations activities. A film on the work and urpose of CCIW was completed. A new and considerably nproved public visits programme was begun, and two new ublications were produced.

The 20-minute colour film takes the viewer into the boratories, aboard the research ships, and into remote eld locations across Canada, showing scientists, tech- icians, engineers and surveyors of the CCIW at work.

This motion picture was important to the success of a ew programme of public visits designed to bring the entre and its work to larger audiences in our 300-seat uditorium. Each of the monthly events had as its highlight, talk given by one of the Centre's many specialists and ustrated with supporting visual aids. In addition to the lm on CCIW, other motion pictures augmented each resentation. Visitors also toured a laboratory specially quipped to demonstrate various pieces of current research nd survey work. Considerable satisfaction was expressed y many of the more than 1,600 who had attended by ear's end.

Exceptionally high lake levels with attendant storms, eavy shore erosion and considerable property damage in ne early part of the year stimulated the production of two ew publications designed to help the public better nderstand the problems and limitations of lake levels

ilm crew from Visual Education Centre aboard M.V. MARTIN ARLSEN shoot CCIW staff at work on Lake Ontario.

Press conference on Great Lakes levels and shore erosion held at the Centre in March 1973.

control. "All You Wanted to Know About Great Lakes Levels" and "Shore Erosion—Cause and Cure" proved immediately popular, and with the volunteered assistance of the Ontario Ministry of Natural Resources, over 75,000 copies were distributed. By December, work was in hand to produce a short film on the subject for distribution the following spring.

Apart from the press conference called in March to launch the above publications and provide answers to the many questions being asked about floods and shoreline damage, over 30 media interviews were arranged for CCIW staff during the year.

Requests for information numbered 1,478.

Apart from several hundred people who took advantage of an "Open Ship" invitation aboard C.S.S. "Limnos" during Environment Week in the autumn, public visitors t the Centre in 1974 totalled almost 5,000.

Through the Speakers' Bureau Service, 32 outsic speaking engagements were undertaken before audienc totalling over 2,200.

Statistics are one thing. Public relations effectiveness another. The question as to what effect these efforts ar those of several preceding years were having in creatir awareness of the Centre and the Department's work ar attitudinal changes required for better water manageme in Canada, was the subject of a special study by outsic consultants begun at year's end. Managed by the Soci Science Research Unit, this study was expected to yield report in March 1974, which will influence the direction future public relations programmes.

Symposium on Water Quality Parameters

Symposium on Water Quality Parameters

CCIW and the Chemical Institute of Canada sponsored ı Symposium on Water Quality Parameters—Selection, Measurement and Monitoring. The 3-day Symposium, held November 19-21, 1973, at the Canada Centre for Inland Waters, was attended by more than 600 scientists from all over Canada and the United States. Other delegates came rom Europe, South America and Japan.

Dr. S. Barabas, Head, Analytical Methods Research Subdivision, was General Chairman of the Symposium. He was assisted by Programme Chairmen W. J. Traversy General and Inorganic Chemistry), A. S. Y. Chau (Organic Chemistry) and B. J. Dutka (Biological Aspects). Dr. B. K. Afghan acted as Secretary-Treasurer while Dr. Mary E. Thompson and Mr. W. Wakeham were responsible for publicity and local arrangements, respectively. Other Programme Chairmen were Mr. O. P. Bhargava of the Steel Company of Canada (Session on Parameter Selection), Mr. V. T. Sayers of the United States Environmental Protection Agency (Session on Continuous Monitoring and Remote Sensing) and Dr. T. G. Brydges of the Ontario Ministry of he Environment (Session on Quality Control).

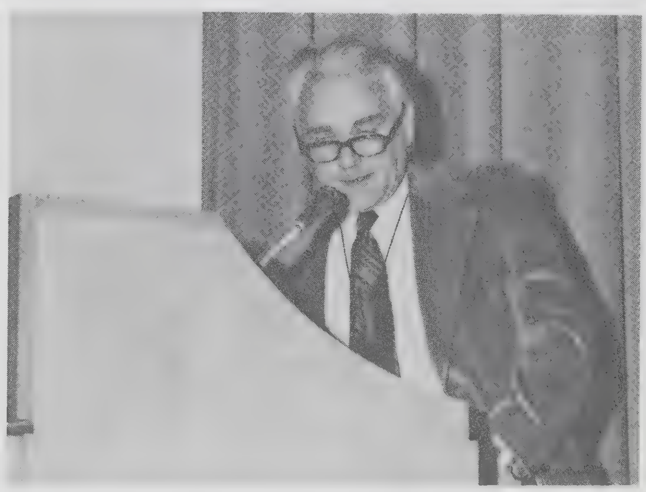
Mr. J. P. Bruce, Director of the Canada Centre for nland Waters, gave the opening keynote address entitled The Role of Research in Lake Management." The second-ay keynote address, given by Dr. R. A. Vollenweider, enior Scientist at CCIW, was entitled "Sources, Pathways, xposure and Risks of Environmental Pollutants."

Ir. Victor Copps, Mayer of the City of Hamilton, presents Dr. S. Barabas with a plaque recording the Mayor's proclamation of 'Water Quality Week" for the duration of the Symposium.

In all, 127 papers were presented in six subject sessions at the Symposium. Of the 49 papers presented by DOE scientists from across Canada, 25 were by CCIW staff; there were 26 contributions by United States' scientists and one from Japan.

The Proceedings of the Conference will be published by the American Society for Testing and Materials (ASTM).

Mr. J.P. Bruce, CCIW Director, introduces the Symposium Dinner Speaker, Mr. Richard Rohmer, author of the current best seller, "Ultimatum."



Dr. R.A. Vollenweider delivers the keynote address on "Sources, Pathways, Exposure and Risks of Environmental Pollutants" to some 400 scientists.

Appendix A • CCIW Staff List

CCIW Staff List

CCIW

irector, CCIW & Director, Ontario Region, Inland Waters Directorate — J.P. Bruce
Secretary — Mrs. C.J. McMunn
enior Scientist — Dr. R.A. Vollenweider
Assistant to Senior Scientist — P.J. Dillon
Secretary — Mrs. S.M. Horne

PUBLIC RELATIONS UNIT

ead — A.R. Kirby
Secretary — Mrs. I. Powell
formation Officer — D.M. Canning
ssistant — Mrs. E.B. Callaghan
isual Aids Officer — I.F. McGregor

ENVIRONMENTAL QUALITY COORDINATION UNIT

ead — Dr. A.R. LeFeuvre
Secretary — Mrs. H. Hetherington
ssistants — J.W. Schmidt
Dr. J.D. Wiebe
G.A. Jones
ientific Assistant — G. Osellame
aining Position — Dr. R.R. Weiler

HYDRAULICS DIVISION

hief — Dr. T.M. Dick
Secretary — Mrs. E. Gervais
dministrative Officer — Mrs. E. Eidsforth
. Y.L. Lau — fluid dynamics
Marsalek — waves, combined sewers
. C.K. Jonys — sediment
. M.G. Skafel — simulation
. G. Tsang — ice and cold
. B.G. Krishnappan — fluid dynamics

ydrometry Unit

ead — P. Engel
chnical Staff — C. Bill, B. Leaney

chnical Services Unit

ead — C. DeZeeuw
chnical Staff — D. Fekyt, Mrs. J. Huehn, K. Pratt, J. Ross, W.K. Stage, G. Voros, D.J. Wagner, W. Welmers

SOCIAL SCIENCES RESEARCH

Head — J.P.H. Batteké — economic studies and information systems.
Secretary — Mrs. R. Riggs
G.E. Bangay — water use and environmental quality in the Great Lakes Basin
P.B. Burns — public law and administration
D.E. Coleman — dynamic modelling and geographic studies
R.G. Davy — legislative and institutional studies
T.D. Leah — toxic substances.
J.L. Pando — economics of water resources and water management
R.M. Shimizu — legislative and institutional studies
M.R. Sinclair — attitude and perception studies.
A.S. Williams — economics of water resource planning.

Support Staff: Mrs. S. Begin
Ms. Marian Kaye
Mrs. J. Thomblison

SCIENTIFIC OPERATIONS DIVISION (INLAND WATERS DIRECTORATE)

Chief — Dr. R.K. Lane
Secretary — Mrs. R.E. Morrison

Microbiology Laboratories

Head — B.J. Dutka — Methods development, water quality assessment
Secretary — Mrs. M. Jurkovic
Dr. A. El-Shaarawi — biometrician (T)
Dr. W.E. Lowe — numerical taxonomy, assessment of trophicity
Dr. M.S. Mahdy — virology consultant
Dr. A.A. Qureshi — P.D.F. — ecology of fungi in Great Lakes
Dr. S.S. Rao — Great Lakes water quality assessment, assimilation studies
Technical Staff — J. Bell, D. Bolton (T), D. Doerffer, J. Henderson, W. Jack (T), A. Jurkovic, S. Kuchma, A. Kwann, R. McGinnis (T), D. Nutley

Physical Sciences Laboratories Section

Head — Dr. R.W. Durham
Secretary — Mrs. L. Roy
T. Pang — electron microscopy
F.A. Prantl — radiochemistry

Radiochemistry Technologists — R.J. Goble, Mrs. E. Csillag (T)
Electron Microscopy Technologist — D. Manolescu (T)

Technical Operations Section

Head — H.B. Macdonald
Secretary — Mrs. L.C. Bouverat
Senior Operations Officer — D.J. Cooper
Senior Diving Officer — J.T. Roe
Operations Officer, M.V. MARTIN KARLSEN — D.J. Brooks
Operations Officer, C.S.S. LIMNOS — D.H. Hanington
Standards and Development Officer — D.J. Williams
P.R. Youakim — IFYGL Centre, Special Projects
L.E. Benner — Meteorological Buoy Project
T.J. Carew — LIMNOS and MARTIN KARLSEN
H.K. Cho — Wave Climatology Beach Stability Study
J. Compton-Smith — transferred from Hydraulics, February, 1973
B.E. Clemmens — LIMNOS and MARTIN KARLSEN
F.J. deVree — Marathon
F.H. Don — LIMNOS and MARTIN KARLSEN; Diving
H. Greencorn — Rigger
P.M. Healey — Operations Officer — C.S.S. ADVENT
J.R. Irwin — LIMNOS and MARTIN KARLSEN, resigned July 1973
G.J. Koteles — LIMNOS and MARTIN KARLSEN
J. Lomas — Foreman Rigger
M.R. Mawhinney — LIMNOS and MARTIN KARLSEN
B.H. Moore — Bay of Quinte
H.K. Nicholson — Shore Sensor Programme
G.M. Perigo — Rigger
J.E. Ross — LIMNOS and MARTIN KARLSEN; Diving; transferred to Hydraulics
S.B. Smith — LIMNOS and MARTIN KARLSEN
W.B. Taylor — Electronics Technician; Meteorological Buoy Programme
M.R. Thompson — Special Projects
S.P. Withers — Operations Officer LAC ERIE; MARTIN KARLSEN
H.W. Zimmermann — LIMNOS and MARTIN KARLSEN
Term Employees — J. Bouwman, J. Hill, W. Jack, B. Killins, J. Lloyd, R. McCrea, D. Moore, K. Salisbury, D. Spry, C. Timmins, E. Walker

Remote Sensing Section

Head — Dr. K.P.B. Thomson (Acting) — remote sensing and lake optical studies
Dr. R.P. Bukata — satellite studies
Dr. H.E. Howard-Lock — consultant — remote sensing of oil spills
Dr. R. McNeil — P.D.F. — remote sensing optic studies
Technical Support — E. Bruton, J. Jerome, H. MacPhail, W. McColl

Data Management Section

Head — Dr. H.S. Weiler (Acting)
Computer Applications
Support Staff — B. Hanson, G.S. Beal, J. Dowell, H.E Comba, B. Pyde, K. Beal, R. Morrov (T), S. Mlynek (T), R. Duffield (T
Data Archiving — W. Nagel
Support Staff — J. Byron, K. Schopf, M.G. Smith, K Miles, J. McAvella (T), J. Sims (T E. Thomson (T)
Special Projects — R. Gottinger
Support Staff — A. Zingaro, D.E. Jordan

SCIENTIFIC SUPPORT DIVISION (INLAND WATERS DIRECTORATE)

Chief — A.S. Atkinson
Secretary — Mrs. L.L. Sutherland

Scientific Services

Instrumentation R & D Engineer — K.N. Birch

Computer Services

Head and Software Specialist — H.C. Pulley
Operations Supervisor — M. Kinder
Computer Console Operators — P. Moody, M. Thomson, P Varga
Peripheral and Keypunch Operator — P. Kirkwood

Library Services

Head Librarian — Mrs. E.A.C. Fosdick
Technical Services Librarian — L.M. Brownlee
Technical Services Clerk — B.J. Davis
Cataloguing Clerk — L.J. Watson
Reference and Circulation Clerk — A.E. Thompson

Engineering Services

Head — G.A. Jones
Secretary — S. McVey

Electronic Engineering

Head — A.S. Watson
Instrument Maintenance and Calibration — A. Eatock
Digital Systems/Logic Design — E. Harrison
Electro-Optical Design — R. Desrosiers
Digital Systems/Logic Design — J. Valdmanis
Electro-Acoustic Design — B. White
Technologists — K. Mollon, J. Diaz, M. Moschos, A. Tyler M. Larocque, M. Pedrosa, A. Fletcher, E. Smith, T Nudds

Mechanical Engineering

Head — A.E. Pashley
Mechanical Engineers — P. Ward-Whate, B. Brady, W Gibson

Technologists — R. Boucher, J. Heidt, H. Saville
Tradesmen — D.H. Whyte, R.V. Chumley, K.K.P. Kalter, J. Bidinost

Drafting and Illustrating

Supervisor — W.D. Finn
Draftsmen — A. Gris, M. Donnely, J. Bodnaruk

Technical Services

Head — D.F. Stewart
Building Maintenance — J. Slaz, G. Clim
Warehouse Supervisor — A.W. Mayes
Warehouse Support Staff — R.J. Haswell, D. Murphy
Stationary Plant Supervisor — K. Pearce (DPW)
Stationary Plant Support Staff — J. Cerniuk, K. Platt, A. Hyslop, J. Thomas, R. Williams, M. Connors, K. Fees, E. Kennedy, J. Smith, A. Morley (DPW)
Security — S/Sgt. R. Legg and twelve members of the Canadian Corps of Commissionaires on rotation.

Staff Services

Financial Services
Supervisor — A. Mitchell
C.C.I.W. Accounts Staff — D. Jefferson, E. Mulvaney, F. Boyd, R. Money, J. Doerr, C. Furlong

Central Registry and Duplicating

Supervisor — E. Rae
Support Staff — B. Titley, J. Hall, H. Green

Stores

Supervisor — C. Hicks
Support Staff — F. Kushner, T.A. Williams

LAKES RESEARCH DIVISION (INLAND WATERS DIRECTORATE)

Chief — Dr. P.G. Sly — distribution and variance of lake bottom sediments
Secretary — Mrs. J.E. Cunningham

Administration

Head — Mr. J.E. Aris (left Dec. 7, 1973)
Secretary — Miss N. Taylor
Support Staff — D. Jefferson, F. Boyd (transferred to CCIW, May 21, 1973)

LAKES RESOURCES SUBDIVISION

Head — Dr. G.K. Rodgers — physical and descriptive limnology
Secretary — Mrs. S. Fauman

Descriptive Limnology Section

Head — F.C. Elder — energy budgets of lakes
Dr. E.B. Bennett — circulation
Dr. N.M. Burns — nutrient cycles, especially organic sedimentation
C.H. Chan — chemical properties of the Great Lakes
H.H. Dobson — nutrients and water quality
M.E. Fox — organic compounds in lakes
A.S. Fraser — analysis of Monitor Cruise data: lower lakes
Dr. W.A. Glooschenko — toxic chemicals; chemical-biological relationships in lakes
Dr. R. McNeil (PDF) — remote sensing and optical properties of lakes
Miss S. Patrick — precipitation chemistry
D.G. Robertson — nearshore thermal regimes
M.T. Shiomi — atmospheric precipitation chemistry, nutrient cycles in large lakes (transferred to Water Quality Branch, April 1, 1973)
Dr. P. Stadelmann — photosynthetic production
N.D. Warry — analysis of Monitor Cruise data: upper lakes
Support Staff — R. Chapil, F. Chiocchio, M. Kerman, K. Kuntz (transferred to Water Quality Branch, Sept. 30, 1973), Mrs. H. Lam, F. Rosa

Regional Laboratories (Freshwater Institute, Winnipeg)

A/Head — Dr. T. Jackson — geochemical limnology
B.C. Kenney — physical limnology (educational leave — University of Waterloo)
W. Warwick — paleoecological interpretation of chironomid fauna
Support Staff — W.R. McGregor, J. Mollison

Regional Laboratories (CCIW Detachment, Vancouver)
Head — Dr. B.E. St. John — trace element geochemistry
Dr. C. Pharo — sedimentary geology of lakes and rivers
Support Staff — G. Bengert

CHEMICAL LIMNOLOGY SUBDIVISION

Head — Vacant
Secretary — Mrs. B. Blain

Water Chemistry Section

Head — Dr. M.E. Thompson — specific ion electrodes, low temperature aqueous geochemistry
Dr. R.M. Baxter — biodegradation of resin acids, nitrogen and phosphorus cycles in lakes
Dr. Y.K. Chau — trace elements and natural complexation in lakes
Dr. R. Gächter (PDF) — modification of metal toxicities by chelates
K. Lum-Shue-Chan — metal-organic interactions in natural waters
Dr. R.F. Platford — electrochemistry of mixed salt solutions
H. Saitoh — trace elements, especially lead compounds in lakes
Dr. W.M.J. Strachan — organic chemistry applied to lakes
Dr. R.R. Weiler — (seconded to EQCU for one year, Nov. 5, 1973) — CO_2:air/lake interactions

Geochemistry Section

Head — Dr. A.L.W. Kemp — distribution and diagenesis of organic compounds in recent sediments, sedimentation rates, geochemical budgets
Dr. V. Cheam — metal fulvate complexes; geochemistry of dredging
C.B.J. Gray — diagenesis of recent organic compounds, especially chlorophyll
Dr. J.O. Nriagu — stable isotopes; stabilities of authigenic minerals
Dr. J.D.H. Williams — sediment/water interface exchanges; geochemical processes in sediments
Support Staff — R.D. Coker, Mrs. N. Harper, Mrs. T. Mayer, Mrs. A. Mudrochova

Impacts and Pathways Section

Head — Dr. D.R.S. Lean — phosphorus, carbon and nitrogen dynamics in lake ecosystems
Dr. B. Brownlee — detergents and organic substances in freshwater systems
Dr. K. Burnison — microbiological ecology
Dr. K. Kaiser — toxic substances (PCB's pesticides, NTA) in the environment
Dr. C. Laio (PDF) — nitrogen metabolism in lakes
Dr. E. Nagy — oil/water studies
Support Staff — M. Charlton, J. Hart, Miss K. McEachern, T. Murphy

GEOPHYSICAL LIMNOLOGY SUBDIVISION

Head — Dr. R.L. Thomas — distribution, occurrence and authigenesis of minerals, major elements and heavy metals
Secretary — Miss N. Taylor

Geolimnology Section

Head — Dr. R.L. Thomas, acting
Dr. T.W. Anderson (GSC) — palynology of recent sediments
J.P. Coakley — distribution, occurrence and relation to erosion, transportation and deposition of active sediments
Dr. V. Damiani (PDF) — sedimentology and applied geochemistry of lakes
Dr. C.I. Dell — stratigraphic correlation and mineralogy, including clay mineralogy, of recent sedimentary sequences
J.B. Henry — geophysical instrumention (left May 24, 1973)
Dr. J.M. Jaquet (PDF) — mathematical geology
Dr. N.A. Rukavina — interpretation of sediment distributions in the nearshore area
A. Zeman — geotechnical and mineralogical studies of recent sediments
Support Staff — W. Booth, R. Dolling, G. Duncan, J. Horseman (GSC), Mr. G. LaHaie, Mrs. L. Mansey, T. Morton, R. Sandilands, D.A. St. Jacques

Physical Limnology Section

Head — F.M. Boyce — internal waves and heat content
Dr. J.O. Blanton — thermal structure and demonstration basin studies
Dr. M.A. Donelan — air/lake interaction
Dr. P.F. Hamblin — circulation and seiches
Dr. D. Lam (PDF) — numerical modelling
Dr. C.R. Murthy — diffusion and circulation
H. Ng — Okanagan — Basin studies and retention times
Dr. T.J. Simons — hydrodynamical modelling
Support Staff — D. Beesley, J. Bull, K. Miners, W. Moody

PALEOENVIRONMENTAL RESEARCH GROUP, WATER RESOURCES DETACHMENT

Coordinator — Dr. L.D. Delorme — ostracode taxonomy and ecology, use of shelled invertebrates in defining trophic state indices
Dr. L.L. Kalas — freshwater and terrestrial mollusc taxonomy and ecology
V.W. Hanson — programmer — systems analyst; paleoenvironmental research
Support Staff — Miss N. Peters

WATER QUALITY BRANCH RESEARCH (INLAND WATERS DIRECTORATE)

ANALYTICAL METHODS RESEARCH SUBDIVISION

Head — Dr. S. Barabas
Secretary — Mrs. R. Andrew
Research Scientists — Dr. B.K. Afghan, Dr. P.D. Goulden Dr. F.I. Onuska, Dr. I. Sekerka, Dr. A.W. Wolkoff
Research Technologists — P. Brooksbank, M. Comba, R Larose, J. Lechner and J. Ryan

WATER AND WASTEWATER TREATMENT RESEARCH SUBDIVISION

Head — Dr. C.P. Fisher
Secretary — Miss Nancy Dale
Dr. A. Netzer — Head, Research Contract Liaison an Coordination Section — ozone
P. Wilkinson — oxone technologist
Dr. H.K. Johnston — Membrane Separation — revers osmosis
H. Huneault — Membrane Separation/reverse osmosi technologist
Dr. B.G. Oliver — toxic materials, heavy metals
E. Cosgrove — toxic materials/heavy metals technologist
Dr. J. Lawrence — water chemistry
Mrs. H. Tosine — water chemistry technologist

GREAT LAKES BIOLIMNOLOGY LABORATORY (FISHERIES RESEARCH AND DEVELOPMENT DIRECTORATE)

irector — Dr. M.G. Johnson
Secretary — Mrs. D. Moore
Typist — Mrs. N. German

DESCRIPTIVE BIOLIMNOLOGY

r. N.H.F. Watson — community analysis; zooplankton
r. M. Munawar — phytoplankton
r. D.G. Cook — benthos
B. Wilson — zooplankton
.F. Carpenter — mysis
echnical Staff — H.F. Nicholson, L.R. Culp, E.L. Mansey, L. Devey, E. Kay, D. Gorney, G. Dupuis, C.C. Loveridge, I.F. Munawar, T. Hall and P.A. Fencott

ENVIRONMENTAL TOXICOLOGY

r. P.T.S. Wong — algae, bacteria
r. W.A. Glooschenko — algae
r. D.G. Wright — invertebrates
echnical Staff — L. Luxon, O Kramer, G. Burnison, B. Blunt, D. Simpson, V. Glooschenko

ECOSYSTEM METABOLISM STUDIES

r. J.R.M. Kelso — fish ecology and production
r. J.M. Cooley — zooplankton ecology and production
.E. Moore — primary production
.K. Leslie — electronic techniques
echnical Staff — R.H. Collins, W.H. Hyatt, M.M. Psutka, B. Moyles, M. Brooksbank, G. Dunlop, C. Charlton, J. Rockwood

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MARINE SCIENCES DIRECTORATE CENTRAL REGION

irector — T.D.W. McCulloch
Secretary — Miss L. Ram.

CANADIAN HYDROGRAPHIC SERVICE

egional Hydrographer — A.J. Kerr
Secretary — Mrs. R. Mikoda

ssistant Regional Hydrographer — E. Brown
Secretary — Mrs. L. Mortimer

ydrographers-In-Charge — Field Surveys
R. Courtnage — Navigational Ranges
F.L. DeGrasse — Great Lakes Surveys
R. Lewis — Playgreen Lake
R. Marshall — James Bay
J. McCarthy — Thunder Bay Survey
J. Statham — Revisory Survey
E. Thompson — Lower St. Lawrence
R. Treciokas — Lake of the Woods
G. Wade — Amundsen Gulf Decca Phase Lag Study
J. Wilson — Arctic Surveys
B. Wright — Chesterfield Inlet
Hydrographers — R. Beri, M. Casey, R. Chapeskie, I. Charron, V. Crowley, M. Crutchlow, K. Daechsel, P. Davies, B. Eidsforth, G. Goldsteen, C. Gorski, K. Hipkin, D. Kimmett, R. Langford, R. Lasnier, C. Leadman, G. Macdonald, J.R. MacDougall, R. Mahaffy, H.J. Marshall, J. Medendorp, R.L. Moulton, E.I. Norman, W.H. Pulkkinen, R. Rehbein, R. Robitaille, W. Silvey, R. Solvason, J.H. Weller, A.P. Welmers

Hydrographic Development

A/Head — R. Bryant
Technical Staff — R. Tripe, C. Doekes, N. Robinson, P. Richards

Marine Information Centre and Local Surveys

Head — A.R. Rogers
Technical Staff — R. McMicking, P. Pagé, J. Kean, M. Grant

U.S. Exchange Program

E. Thompson — U.S. Lake Survey
P. Heltunen — U.S. Exchange

Cartography — Drafting

Head — J.C. Elliott
Technical Staff — S. Holm

RESEARCH & DEVELOPMENT DIVISION

A/Head — N.G. Freeman
Secretary — Mrs. J. Fiddes

Shore Property Studies Section

Head — W.S. Haras
R. Boulden
D. Paganucci
V. Rawlins
J. Shaw
G. Willson
8 — Co-op Students

Hydrodynamics Section

Head — N.G. Freeman
L. Barfoot
J. Gervais
L. Muir

T. Pullen
S. Venkatesh
1 — Co-op Student

Survey Electronics Section

Head — E.O. Lewis
Shop Foreman — W.W. Smith
H. Boyce
G. Kavanagh
P. Millette
W. Montgomery
M. Moore
A. Prudhomme
D. Pyatt
B. Waldock

SHIP DIVISION

Regional Marine Superintendent — A. Quirk
Secretary — Mrs. F. Haaka
Engineering Superindent — A.T. Hughes
Shore Boatswain — W.S. Corkum
Shop Foreman — K.D. Robertson
Shop Staff — M. Ames, J. Boyle, D. Cook, J. Fasullo, V. Rahelic, J.A. Vanderslikke

C.S.S. "Limnos"

Master — Capt. N.L. Keeping
Officers — M.C. Birchall, R. Dean, T.C. Kenney, G. Sproule, J. Stansfield (11 Ships Crew)

C.S.S. "Advent"

Master — Capt. I. Williams
Officer — R.R. Charles (2 Ships Crew)

Launches

Scientific Support — 18 Seasonal Ships Crew
Hydrographic Surveys — 70 Seasonal Ships Crew

ADMINISTRATION SERVICES DIVISION

Regional Administrative Officer — A.W. Appleby
Secretary — Miss J. Major
Assistant Administrative Officer — B.J.T. O'Hagan
Office Manager — J.R. Dobson
Accounts — A.B. Mitchell
Procurement & Sotres — E.R. Gibbons
Support Staff — Mrs. J. Crescuolo, B. Day, C.J. Fulton, Mrs. L. Gibson, Miss M. Girouard, Mrs. F.M. Hannay, J. Mellon, J.G. Rothwell, Mrs. P. Taylor, T.H. Taylor

ENVIRONMENTAL PROTECTION SERVICE

TECHNOLOGY DEVELOPMENT AND DEMONSTRAT DIVISION

Director — Dr. J.D. Salloum
Secretary — Mrs. V. Westaway

Process Development Section
Head — N.W. Schmidtke
Physical Processes Unit — Dr. B.P. Le Clair
Biological Processes Unit — Dr. B.E. Jank
Chemical Processes Unit — Dr. E.E. Shannon
Soil Processes Unit — Dr. V.K. Chawla

Demonstration Section
Head — R.E. Mills

Laboratory Services Section
Head — K. Conn

Facilities Services Section

A/Head — A.D. Stephenson
Stores — D.M. Niles

Scientific and Professional Staff

D.W. Bissett, V.W. Cairns, H.W. Campbell, Dr. H.M. Guo, P.M. Huck, J.R. Knechtel, Dr. J.K. Kurcharski, J.F. McK J.P. Stephenson, W.E. Stepko, Dr. D.L. Liu

Administration

Administrative Officer — J. Dobson
EPS Accounts — Mrs. J. Crescuolo
Support Staff
Stenographic and Clerical — Mrs. R.L. Veerdonk, Mrs. Perrone, Mrs. S. Lawson, Mrs. M. Wilson
Technical and Operational — G.A. Anthony, W.K. Bedfo D.N. Bryant, P.J. Crescuolo, P.J. Fowlie, J.L. Fra R.G. Gillespie, D.H. Ide, Mrs. K. Kwasniewska, Ladouceur, G.J. Lawrence, S.C. Lee, N.C., Longhu E.G. Luxon, S. Metikosh, B.A. Monaghan, J. Sa A.R. Stickney, D.T. Vachon, P.A. Van Hardeveld

ENVIRONMENTAL EMERGENCY BRANC CENTRE OF SPILL TECHNOLOGY

Head — Dr. S.L. Ross
Dr. W.J. Lem — Oil Spill Treating Agents
Mr. W.J. Logan — Mechanical Equipment

INLAND WATERS DIRECTORATE
ONTARIO REGION OPERATIONS

WATER QUALITY BRANCH

WATER QUALITY LABORATORY AND NETWORK

ead — W.J. Traversy
Secretary — Mrs. V. Walker
dministrative Officer — W.M. Wakeham

nalytical Services Section

ead — F.J. Philbert
organic Analysis — D.P. Sturtevant
ip Support Laboratory — O. Elkei
rganic Analysis — R.C.J. Sampson
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uality Control — D. McGirr
ethod Development — K. Aspila
hemists — H. Agemian, J. Coburn

onitoring and Surveys Section

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pport Staff — K.W. Kuntz

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urlington Office

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Secretary — Miss D.M. Smith
ngineers — J.D. Keefe, D.W. Brown, W.M. Jones, P.P. Yee
echnical and Support Staff — C.L. Hanes, J.P. Charron, R.J. Lloyd

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Support Staff — R. A. Rees

Niagara River Board of Control — W. M. Archer

Appendix B • Publications and Presentations

APPENDIX B

ublications and Presentations

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Appendix C • Contracts and Grants

;ontracts and Grants

To construct and test a bank of six or eight simulator ɔlumns; half to be used for studies simulating sediment/ ater exchange processes under lacustrine conditions, and alf to study biotic processes under controlled lighting and ıermal structure regimes. Phase II (Techwest, Vancouver $150,000). (Contract liaison by LRD and FRB-CCIW).

Repair, overhaul, modification and reduction to spares f Recording Current Meters and associated equipment, ıcluding Special Investigations and Technical Studies, both and out of the plant. (Canadian General Electric ɔ. – $95,000).

To design, supply and erect at site Cold Rooms A, B ıd C. (Crescent Air Conditioning Ltd. – $92,098).

Design of Wind/Wave Flume. (Dilworth, Secord, eagher & Associates Ltd. – $92,000).

Design, supply, install and test wave generation equip- ent. (MTS Systems – $88,597).

To assess the effect of selected dredging and dumping tivities on a BEFORE, DURING AND AFTER basis. udies have been designed to look at the physical and /drographic aspects of the sites, the geochemistry and ıgineering properties of the sediments, and the related ınthic communities. (In addition, special studies have en made to look at the possibilities of exchange which ay take place in sediment plumes related to both dredging d dumping activities. A preliminary assessment of re- ɔpulation of benthic forms is also included.) (Chemex- ıvirocon Ltd. – $55,000, extended by $21,000 to '6,000).

To design and supply a fan and drive system for the nd/wave flume. (Sheldons Engineering Ltd. – $73,184).

To apply a physical-mathematical model to estimate e potential benefits and costs if offshore diffusers were ıployed for waste heat rejection to the Great Lakes. .G. Acres Consulting Services Ltd. – $53,500).

To design and supply a reversible, variable speed pump r the wind/wave flume. (Peacock Brothers Ltd. $34,237).

Development of a submersible sensing head. (Dilworth, cord, Meagher & Associates Ltd. – $21,000).

To determine the water loss from the Great Lakes sin due to waste heat discharge to be expected by the ar 2000. (H.G. Acres Consulting Services Ltd. $19,800).

Development of electrochemical devices for use as vironmental sensors to detect and measure dissolved ygen, water vapour and velocity of water currents. (Trent ıiversity – $19,107).

To provide a team of eight technicians to perform ɔoratory services for the Department of the Environment with water samples. (Technical Services Laboratories – $19,000).

To compile radiation measurements from over Lake Ontario during the International Field Year and develop a radiation balance model for Lake Ontario (Department of Geography, McMaster University – $17,624). Prof. John Davies.

Reduction and analysis of radiation data collected during the International Field Year on the Great Lakes. (McMaster University – $17,624).

To provide X.R.F. and analyses of Great Lakes bottom sediment samples, to show the regional distribution of major and trace elements and nutrients, and to provide data for factor analysis and correlation of variables. (Poseidon Consultants, B. Cook – $15,000).

To calibrate an X-ray Fluorescence Spectrometer for 36 major and trace elements for the analysis of dredged sediments at CCIW. (Poseidon Consultants Inc. – $15,000).

Analysis of a pump test from a well penetrating several aquifers to determine the characteristics of individual aquifers. (James F. MacLaren Limited – $13,000).

Examine effectiveness of CCIW public relations programme. (Resources Management Consultants Limited – $13,000).

Pilot plant studies on biological nitrification/ denitrification. (McMaster University – $12,500).

Supply engineering services for sediment handling equipment. (Reid, Drowther, & Partners Ltd. – $12,000).

Examination of Ottawa River water and recreational waters for human pathogenic viruses. (University of Ottawa – $11,945).

The establishment and development of sensitive techniques for the concentration and detection of small amounts of virus in large volumes of water. (University of Western Ontario – $10,250).

Studies on detection of animal viruses in farm effluent. (University of Guelph – $10,250).

Applicability of Vollenweider's model to small lakes. (University of Toronto – $9,998).

To design and evaluate a bank of eight simulator columns, approximately 1 m diam. x 4-5 m high; and to conduct materials testing to ensure a contaminant-free system. Phase I (Techwest, Vancouver – $9,900). (Contract liaison by LRD and FRB-CCIW).

Advise on water quality criteria in the Great Lakes with respect to potentially polluting substances. (D.H. Matheson – $8,000).

To study the atmospheric contribution to loading of nutrients, heavy metals, and toxic materials to the waters of the upper Great Lakes. (D.H. Matheson – $8,000).

To investigate the effect of winter ice action on shoreline erosion on Point Pelee, Ontario. (Industrial Research Institute, University of Windsor, Dr. G.J. Dickie – $7,382).

Provide consulting services in the design of a magnesium carbonate pilot plant. (Cambrian Engineering Group Ltd. – $5,500).

To provide electronic and data processing support. (J. & F. Associates – $5,400).

Analysis of organic carbon isotope ratios of Lakes Ontario and Erie plankton, bottom sediment, and bluff materials. (University of Waterloo – $5,000).

Analysis of organic carbon isotope ratios in 80 samples of Lakes Erie and Ontario plankton. (University of Waterloo – $5,000).

Provide analytical services to a research program on the Bay on Quinte. (University of Guelph – $5,000).

To carry out chemical analysis, to determine the carbon 12/carbon 13 isotope ratios of photoplankton – sediment organic matters – bluff materials – and suspended load from selected samples around Lakes Ontario and Erie. (University of Waterloo, Earth Sciences. Dr. P. Fritz – $5,000).

To analyse water level and current meter data collected in the Oshawa region of Lake Ontario and during the IFYGL for edge waves and compare the results with the predicted behaviour. (Mr. James R. Salmon – $4,900).

To conduct a high resolution seismic profiling survey in the nearshore zone of the Scarborough Bluffs. (Ter-mar-ex Limited – $4,500).

The effect of run-off from cattle feedlots on the water quality of receiving streams. (York University – $4,305).

To assess by means of controlled greenhouse experiments, the ability of polluted sediment materials taken from selected dredged sites in the lower Great Lakes in 1973, to develop desirable textural conditions and to support plant growth, and to study the relative uptake (plant) and residue (in soil) of various toxic/trace metal components. (Miss June Judge – $4,000).

Research study on the biological conditions of the Lower Great Lakes. (University of Waterloo – $3,500).

Heat content surveys on Lake Ontario. (University of Toronto – $3,474).

Analytical services as part of a study of the Bay of Quinte. (University of Guelph – $3,300).

Examination of methods of treating contaminated bottom sediments, and preparation of a program of work designed to identify and develop processes with high potential. (Acres Consulting Services Ltd. – $3,000).

To examine methods of treating contaminated bottom sediments and to prepare an outline design to study and identify and develop processes related to mechanical inversion, pelletizing or chemical stabilization, and bottom sealing. (H.G. Acres Consulting Services Ltd. – $3,000).

Calibration of X.R.F. facility, at CCIW, for online analyses of an extended selection of trace metals. (Poseidon Consultants, B. Cook – $2,000).

To complete ongoing studies on metal fulvate complexes in relation to natural and artificial chelation activity. (Dr. V. Cheam – $1,500).

To determine whether palynological techniques can b used to date nearshore sediments of sand size in the sam manner that they have been applied to finer basin sed ments. (Miss G. MacInnis – $1,300).

The following contracts were let by CCIW and funded under the Canada-Ontario and Canada-United States Agreements on Great Lakes Water Quality.

Land Application of sewage sludges. (University o Guelph – $119,660).

Dredging impact study. (Chemex-Envirocor Ltd. – $55,000).

Waste heat mathematical model development and benefit analysis of offshore diffusers. (Acres Consultin Services – $53,500).

Urban Runoff study. (James F. MacLaren Ltd. – $50,000).

Settling behaviour of physical-chemical slurries. (University of Toronto – $28,000).

Assessment of polymers as aids to removal of phosphorus from waste-water. (McMaster University – $25,543).

A study to identify hazardous polluting substances and specify realistic concentration limits. (James F. MacLaren Ltd. – $20,000).

Economic impact of possible price increases resultin from management of waste heat discharge. (Canadian Resourcecon Ltd. – $20,000).

Comprehensive compendium of critical sedimen motion data for mobile boundary channels. (Northwes Hydraulic Ltd. – $20,000).

Study of the recovery of metals from sludge incinerator ash. (Cambrian Processes Ltd. – $20,000).

Land application of sewage sludge under advers conditions. (Regional Municipality of Niagara – $19,000

Effects of waste heat inputs. (Acres Consulting Services – $19,800).

Feasibility of chemical regeneration of activate carbon for use in municipal wastewater treatment. (Canadian Industries Ltd. – $18,800).

Studies to control and treat combined sewer overflow (Acres Consulting Services – $17,000).

Development of a computer-aided technique for th design of regional sludge disposal systems. (B&P Silvesto Ltd. – $16,800).

Studies to control and treat combined sewer overflow (Pollutech Pollution Advisory Services Ltd. – $15,900).

Study to refine the computer model to predic equilibrium conditions within the sewage lagoon. (Pollutec Pollution Advisory Services – $15,000).

Effluent polishing by filtration through activate alumina. (Pollutech Pollution Advisory Services – $15,000)

Methods of reclaiming phosphates and metals fro activated sludges. (University of Waterloo – $14,471).

Removal of nutrients from water samples by parti ozonation. (University of Sherbrooke – $14,271).

Establish viable methods of maintaining waste trea ment facility efficiencies. (James F. MacLare Ltd. – $13,700).

Novel vessel waste treatment systems. (James

ΛacLaren Ltd. — $12,050).

Study of the economic consideration of the solidifica-ion of phosphate sludges using industrial sulphate waste nd fly ash. (Acres Consulting Services — $12,000).

Examination of sewage and sewage sludge for entero-iruses. (Ontario Ministry of Health — $11,000).

To provide specific information concerning nature and ocation of specialized land use categories in the Great akes Basin. (Crysler and Lathem, Consulting Engineers nd Resource Planners, Willowdale, Ontario. — $10,400).

Aerobic digestion of organic sludges containing inor-anic phosphorus precipitates. (University of To-onto — $10,000).

Determine behaviour of heavy metals applied in chem-cal sewage sludges to agricultural land. (University of oronto — $10,000).

To prepare and conduct a Technology Transfer Design eminar concerned with phosphorus removal. (James F. ΛacLaren Ltd. — $10,000).

Lake Column Simulator — Phase I feasibility study. Techwest Enterprises Ltd. — $9,930).

Evaluation of Barber-Colman Wetox process for sewage udge disposal. (Ontario Research Foundation — $9,000).

Technology Transfer Design Seminar on phosphorus emoval. (James F. MacLaren Ltd. — $5,000).

To undertake a legal analysis of potential public articipation in water resources management in Canada. (G. lorley, University of Manitoba — $5,000).

Construct a prototype bed level plotter. (Mr. Roy itzel — $4,000).

Design and inspection of motor drive for instrument arriage of the 2M flume. (Dilworth, Secord, Meagher & ssociates Ltd. — $4,000).

Handling of quicklime for phosphorus removal. (Con-ol & Metering Ltd. — $3,000).

Study of four basic ship sewage treatment systems as art of the programme on novel vessel waste treatment. ollutech Pollution Advisory Services Ltd. — $2,900).

To analyse survey data on the Attitude of Municipal fficials toward innovative treatment techniques. (R. chlin, Toronto — $1,500).

To research the economic of information. (Professor J. Vorst, University of Manitoba). IWD, Ottawa.

Physiological and ecological studies of the bacterial ora of the Saint John River in relation to industrial ollution ($24,580). Drs. Mervin and Maxine Franklin and r. W. Coulter, University of New Brunswick.

Traitements biologiques des eaux usées. ($15,000). of. R. E. Simard, Laval University.

Bacterial ecology in relation to water quality in the tawa River. ($13,500). Dr. D. J. Kushner and Dr. J. B. mstrong, University of Ottawa.

Studies on the efficiency of available techniques for e concentration and recovery of viruses and the examina-n of Ottawa River water and recreational waters for the presence of human pathogenic viruses. ($11,945). Dr. J. C. N. Westwood, University of Ottawa.

The establishment and development of sensitive techniques for the concentration and detection of small amounts of virus in large volumes of water. ($10,250). Dr. E. L. Medzon, University of Western Ontario.

Studies on the detection of animal viruses in farm effluents. ($10,250). Dr. J. B. Derbyshire, University of Guelph.

The examination of recreational water for the incidence of pseudomonas aeruginosa and coagulase positive staphylococcus aureus and their potential as indicators of water quality. ($9,920). Pat Seyfried, Dept. of Hygiene, University of Toronto.

Decomposition of water pollutants by aquatic fungi from polluted waters in New Brunswick. ($3,700). Dr. N. J. Whitney, University of New Brunswick.

Confirmatory Tests for the identification of pesticide residues as effected through reduction with sodium naphthalenide. ($4,994). Waterloo Research Institute, University of Waterloo.

ERTS Contracts

Optical studies for assisting in the evaluation and interpretation of ERTS satellite imagery relating to water quality ($23,600) *Phase I:* Design, assembly and testing of transmitter-receiver system. Conduct propagation and scattering studies at CCIW to determine feasibility of the system as a workable water Lidar. *Phase II:* Operational field test on board CCIW research ship. Prof. A. Carswell, York University.

Application of satellite imagery to the study of Big Quill Lake. ($23,560). J. Whiting, Saskatchewan Research Council.

Application of satellite imagery to the study of the St. Lawrence Valley area in particular Lake St. Louis and Lake St. Pierre. ($12,568). Dr. A. Soucy, Centre de Recherches sur l'eau, Laval University, Quebec City.

Application of satellite data to freeze-up, break-up and changing configuration of lakes in Northern Quebec and Labrador. ($9,210). Dr. J. T. Parry, McGill University.

Application of ERTS imagery to the study of the ice regime on Lake Erie and the reservoir areas above the Churchill Falls power development in Labrador. ($3,500). Mr. P. J. Denison, H. G. Acres Consulting Services Limited, Niagara Falls.

Application of satellite imagery to the inventory of the surface and ground water patterns in the Cooking Lake and Gull Lake basins in Alberta, Canada. ($3,209.40). Prof. A. H. Laycock, U. of Alberta, Edmonton, Alberta.

Application of satellite imagery to water mass delineation of western Lake Ontario. ($2,714). Dr. J. C. Munday, Jr., Erindale College, U. of Toronto.

CANADA CENTRE FOR INLAND WATERS,
BURLINGTON, ONTARIO, 1974.

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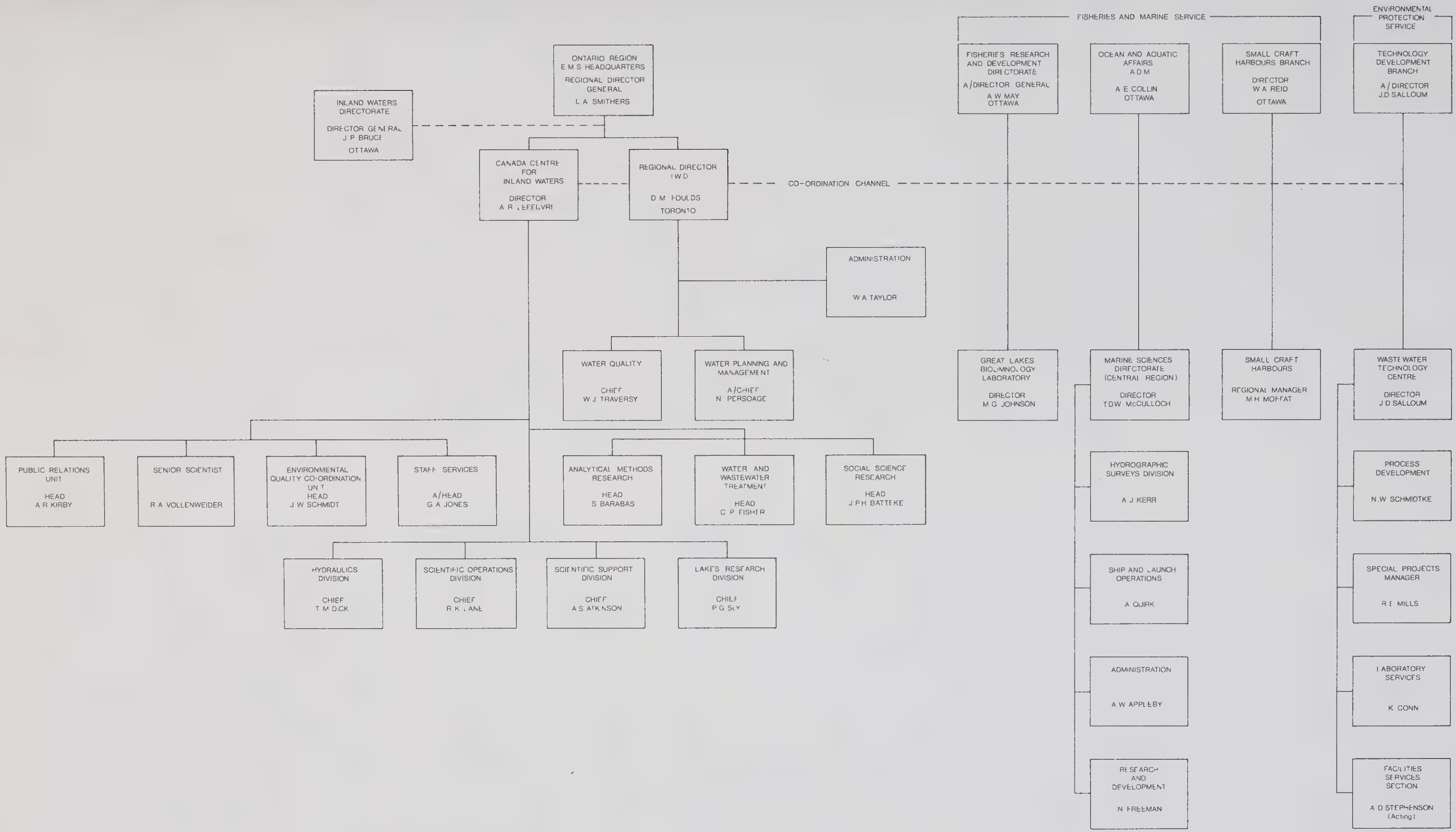


Canada Centre for Inland Waters Organization, December 31, 1974.

ighlights in Review

IMPLEMENTATION OF GREAT LAKES WATER QUALITY AGREEMENT

A major share of CCIW activities continued to be ected toward the implementation of programs required the 1972 Canada-United States Great Lakes Water ality Agreement. A significant number of staff members rticipated in the work of International Joint Commission C) Boards, Committees and Reference Groups estab- ned under the agreement. Specific activities undertaken luded:

For the Upper Lakes Reference, Inland Waters Directorate (IWD) and Great Lakes Biolimnology Laboratory (GLBL) components conducted comprehensive physical, chemical, sedimentological and biological surveys of Georgian Bay, the North Channel and Lake Huron. An evaluation of the impact and dispersal of a major industrial effluent source in Lake Superior was continued in collaboration with the industry involved. Inland Waters Directorate personnel, along with other agencies, developed a waste-loadings policy simulation model for the study of long-term waste discharges of approximately 50 nutrients and contaminants in the upper Great Lakes. Similar systems analysis techniques are now being used to estimate future patterns of land uses in the region.

In collaboration with the Ontario Ministry of the Environment (MOE), Inland Waters Directorate and Environmental Protection Service (EPS) personnel were actively engaged in studies of the reduction of pollution caused by combined sewer overflows and storm water discharges. The major effort was a contracted study to develop a mathematical model as a management tool to evaluate the impact of various control measures.

Surveillance programs on the lower Great Lakes and interconnecting channels continued in collaboration with the Ontario Ministry of the Environment and United States agencies. In addition, GLBL personnel conducted a pilot surveillance program on Lake Ontario to evaluate the impact of pollution control measures on water quality, particularly with respect to the biotic community. This is a long-term effort with anticipated expansion into the upper Great Lakes.

Great Lakes Biolimnology Laboratory personnel conducted preliminary laboratory experiments using lake-column simulators to test the effects and potential for biomagnification of contaminants detected in dredged spoils and agricultural land runoff. Experiments to determine the effects of dredged spoils disposal on the aquatic communities were also carried out on Lake Erie (Port Stanley) and Lake St. Clair (Mitchell Bay) in co-operation with the Ontario Ministry of Natural Resources (OMNR) and other agencies. IWD conducted hydraulic studies to determine the degree of spreading of dredged materials when dumped into deep waters, as well as geochemical studies of dredged sediments.

5) Physical, chemical and biological projects were undertaken to provide a sound scientific basis for water quality objectives for waste heat and some toxic substances listed in the agreement. Significant activities were field studies, conducted by GLBL personnel at the Nanticoke Thermal Generating Station on Lake Erie, to elucidate the temporal and spatial relationships in freshwater flora and fauna and their disruption in mixing zones caused by thermal effluents. Physical studies were conducted at Baie du Doré-Douglas Point as well.

6) Significant contributions were made to the development of the study plan of the Pollution from Land Use Activities Reference Group.

7) Activities were initiated involving the development of an Annex on Hazardous Polluting Substances for the agreement. A list of 1200 hazardous materials, in descending order of potential danger to the aquatic environment, was compiled according to the criteria of toxicity to aquatic life; amounts used in commerce and industry; and mode of transport and storage. This work was carried out under contract and monitored jointly by GLBL and EPS personnel.

8) In the International Joint Commission's Second Annual Report on Great Lakes Water Quality, research on the hazards of waterborne viruses was recommended. A number of virology contracts were supervised by scientists at CCIW. The research developed isolation and enumeration techniques for viruses found in sewage, sludge, effluent, receiving and recreational waters.

In November at CCIW, a meeting of Canadian experts was held to determine the feasibility of an epidemiological approach to assess existing and potential health hazards due

to viruses in water. At this meeting, two preliminary studies were proposed to relate viral infection to water supplies and to viruses present in raw and treated sewage.

Some of the major field projects undertaken follow.

HYDROGRAPHIC SURVEYS–MSD

A hydrographic survey was completed of Chesterfield Inlet from Hudson Bay to Baker Lake, using the automated data acquisition system (HAAPS). Efficient operation resulted in the completion of a two-year program in one year. Another successful hydrographic survey was carried out in the Chenal de l'Île d'Orléans in the St. Lawrence River. This survey, related to the deep dredging southeast of Île d'Orléans, was conducted under a contract with ComDev Marine.

Coordination of oceanographic research in James Bay was established by scientists at the James Bay Workshop, June 26, 1974. By the end of the year, Central Region had established a mandate for conducting oceanographic surveys in Hudson and James Bays.

BAY OF QUINTE PROJECT – LAKE ONTARIO

A research project, involving the co-operation of personnel from Fisheries Research and Development Directorate (FRD), Inland Waters Directorate and the Ontario Ministries of Natural Resources and the Environment, was continued on the Bay of Quinte. One of the principal objectives of this project is to determine the response of the biota to the phosphorus removal program undertaken in accordance with the Canada-United States agreement.

A set of limnocorrals has now been in position in the Bay for one and one half years. The path of phosphorus movement through the ecosystem to sediments was traced using radioactive phosphorus. The turnover period of the phosphate pool was evaluated to be as rapid as two minutes.

Measurements of the rate processes that influence the growth rate and abundance of algae in lakes were completed. Experiments included observations of changes in biomass that result from decreasing nutrient loading. Grazing experiments have shown that zooplankton can graze on up to more than 200% of the plankton each day.

POINT PELEE – LAKE ERIE

A comprehensive, multidisciplinary investigation of the respective roles of the physical processes, sediment transport and commercial dredging on the erosion losses at Point Pelee was launched by various components of IWD and MSD. Of concern was the impact of commercial dredging in the sand shoals off the coast of Point Pelee. The shoals are thought to be the source of sediments that is reinforcing the eastern coast of the Point. Wave measurement studies provided data on long-term erosion-accretion processes at Point Pelee. A number of remote sensing techniques were developed and used to determine sedimentary and littoral processes around the Point.

A report on the formation, evolution and effect of commercial sand dredging operations around the Point is nearing completion.

IWD PROJECTS OUTSIDE THE GREAT LAKES BASIN

A major physical limnological study was undertaker on Kamloops Lake, British Columbia. A number of short term applied studies were also commenced in severa other regions. These included a study of copper complexation in Babine Lake in British Columbia, a study in Lesser Slave Lake and assistance in the limnological aspects of a comprehensive study in the Shubenacadie River basin Nova Scotia. Staff continued to participate in the planning of a federal-provincial study on Lake Winnipeg, and a draft plan was completed.

HIGH WATER ON THE GREAT LAKES

Erosion and flooding in the Great Lakes-St. Lawrence system, although not as extensive as in 1973, remained as serious problems, since lake levels remained high.

At CCIW, MSD and IWD staff continued shor erosion studies as part of the Canada-Ontario Shore Damag Survey. It is expected that the Technical Report and th Coastal Zone Atlas will be published in mid-1975.

INSTRUMENTATION DEVELOPMENT – MSD

Instrumentation development was highlighted by th design and operation of the INDAPS data processin system, whereby hydrographic data can be collecte and processed in the field. This system was successfull implemented in the Lake Winnipeg Survey. The Electronic Shop greatly increased the signal strength and rang of the Minifix system, by using 70-foot towers an 100-watt transmitters. In oceanographic instrumentation six Aanderaa recording current meters were successfull converted to profiling C.T.D. units (conductivity, temperature, depth), and simulated arctic tests were carried ou

ENGINEERING AND SUPPORT SERVICES — IWD

During the year, Engineering Services supported IWD research activities. Developments involved remotely controlled sensor modules for water chemistry, inshore towers for air-water studies, programmed lighting systems for biological studies, standardized electronics and mechanics for water temperature surveillance, procurement and testing of fish censusing gear, design and procurement of flumes for the Hydraulics Division Laboratory, special coring devices for geological studies, long-term monitoring systems for lake dynamics, underwater light-scattering instrumentation, and automatic sampling gear for lake nutrient modelling, as well as general support such as consulting and maintenance.

Effort was also applied to the final design and construction of REX, a submersible system for *in situ* measurement of water quality parameters, and the final development phase of a long-term dissolved oxygen sensor.

ENVIRONMENTAL TOXICITY PROGRAM

Toxicity studies of lead and cadmium were conducted on various species of fish, algae and benthic invertebrates. Preliminary results indicated cadmium to be more toxic than lead to algae. Several experiments on the methylation of lead and the biofractionation of sulphur isotopes were conducted in collaboration with IWD scientists.

ASBESTOS FIBRES — GREAT LAKES WATER QUALITY AGREEMENT

In the past several years, questions have been raised about the potential hazard of asbestos fibres in water supplies. In response, several projects were initiated in collaboration with the Ontario Ministry of the Environment.

Mapping of the distribution of the fibres, both in the waters and in the sediments of Lakes Superior and Huron, was undertaken. Concentrations were determined in samples using electron microscopy in the Physical Sciences Laboratory.

A technique for the removal of the fibres from potable water supplies was developed by IWD personnel. The method removes 99.8% of the asbestos fibres and can be added to virtually all existing water treatment plants that have sand filtration equipment. Inland Waters Directorate is presently engaged in a joint project with the Ontario Ministry of the Environment to implement the process in a pilot plant.

GREAT LAKES MODELLING

The modelling program involved simulating water levels, currents, temperatures and the transport of suspended material in Lakes Ontario and Erie. The hydrodynamic phase of the modelling project in Lake Ontario was completed in 1974, with a verification study based on the physical data collected during the International Field Year for the Great Lakes (IFYGL).

A computer model for possible toxicant spills in Lake Ontario was developed. The model can accommodate one or more parameters, such as toxicant concentrations or counts of living organisms.

With respect to modelling efforts in Lake Erie, a computer model was designed for the lake-wide time-dependent simulation of the diffusive and advective transport of nutrients (chloride). The chloride model was also extended to include other substances, such as phosphorus.

The modelling program in Lake Ontario was directed toward the development and verification of biochemical submodels, using 1972 IFYGL data.

EPS WASTEWATER TREATMENT TECHNOLOGY DEVELOPMENT

A joint federal-industrial project, involving the operation of a pilot-scale two-stage activated sludge system treating kraft bleachery effluent, was carried out at Eddy Forest Products, Espanola, Ontario.

The biological nitrification research project, initiated with McMaster University in 1972, continued throughout 1974. Detailed studies were carried out to examine various flow and process configurations.

The joint federal-provincial-industrial study, started in 1972 for the development of mine and mill wastewater treatment technology in the base metal mining industry, continued. Pilot-scale studies for the biological oxidation of thiosalts were carried out at the Brunswick Mining and Smelting Corporation site in northeastern New Brunswick.

A study of the recycling of liquid sewage sludge on dredged river sand was completed in British Columbia.

ENVIRONMENTAL ASSESSMENT

Under the recently instituted Environmental Assessment Review and Protection (EARP) Process,

environmental aspects were considered in the planning and implementation of all projects with federal involvement, and environmental assessments were made of projects that may have significant adverse effects on the environment. Staff members at CCIW were involved in the administration and implementation of the Process, by reviewing projects for potential adverse environmental effects and advising on the need for and content of environmental assessments. CCIW staff also participated in base-line studies required for environmental assessments and in the review of environmental impact statements.

AMERICAN FALLS AT NIAGARA

The American Falls International Board Study of measures necessary to preserve and enhance the beauty of the American Falls at Niagara was completed, and the Final Report was submitted to the International Joint Commission. Support for this study was provided by Inland Waters Directorate Regional staff.

RESEARCH REPORTS AND CONFERENCES

About 365 papers by CCIW staff were presented at conferences and published in journals and departmental publications during 1974 (Appendix B). Dr. T. J. Simons again won the Chandler-Misener Award for the best paper presented to the International Association for Great Lakes Research (IAGLR).

In 1974, four major conferences were held by CCIW. In February, the staff of the Wastewater Technology Centre hosted a NATO/CCMS meeting. Seven countries were represented in the discussion of the status of the physical-chemical waste treatment demonstration pilot plant now under construction in the United Kingdom at Colehill. The United Kingdom is the pilot country; Canada is one of the co-pilot countries. In early March, the 13th Annual Canadian Hydrographic Conference, attended by 200 persons, was hosted by Marine Sciences Directorate, Central Region. The 17th Annual Conference on Great Lakes Research, co-hosted with McMaster University, was held on August 12 to 14, in Hamilton. In Toronto on September 18 and 19, staff participated in the 2nd Canada-Ontario Agreement Workshop, which had the theme, "Sludge Handling and Disposal."

PUBLIC RELATIONS

In June, the Public Visits Program completed a highly successful 10-month series of lectures covering a wide spectrum of topics given by various scientists. These presentations were enjoyed by a total of more than 3200 people.

During the year, program emphasis shifted from the local to a national audience. This decision coincided with completion of two films, "Not Man's to Command" and "Second Frontier." The first film shows the regulation and control of lake levels. In association with the National Film Board and with the co-operation of the Ontario Public Library system, "Not Man's to Command" was viewed by audiences numbering several hundred thousand. "Second Frontier," which explains the Centre's work and purpose, will be distributed nationally.

The Unit was also asked to assist the International Joint Commission in a series of public hearings to discuss further regulation of Great Lakes levels.

INTERNATIONAL INVOLVEMENT

In 1974, CCIW was formally designated as the World Health Organization (WHO) International Collaboration Centre for Surface and Ground Water Quality. Thus the Department can more effectively assist the developing nations with their water management programs.

CCIW remained the lead institute for the North American contribution to the Organization for Economic Co-operation (OECD) measurement program on lake eutrophication.

Faits saillants

MISE EN APPLICATION DE L'ACCORD RELATIF À LA QUALITÉ DE L'EAU DANS LES GRANDS LACS

Les efforts du CCEI ont porté en grande partie sur la mise en application de l'Accord canado-américain de 1972 relatif à la qualité de l'eau dans les Grands lacs. Un nombre important de membres du personnel ont collaboré avec les organismes établis en vertu de l'accord: conseils de la Commission mixte internationale, comités et groupes d'acquisition de données. Voici quelques-unes des activités entreprises:

1) Pour ce qui est de l'acquisition de données sur le bassin supérieur des Grands lacs, certains services de la Direction générale des eaux intérieures et du Laboratoire de biolimnologie des Grands lacs ont entrepris des relevés physiques, chimiques, sédimentologiques et biologiques approfondis de la baie Georgienne, du chenal Nord et du lac Huron. L'évaluation des conséquences et du degré de dispersion dans le lac Supérieur d'une source importante d'effluents industriels s'est également poursuivie en collaboration avec l'industrie responsable. Le personnel de la Direction générale des eaux intérieures a mis au point, avec d'autres organismes, un modèle de simulation pour la politique de déchargement des déchets; ce modèle servira à l'étude de déversements à long terme d'environ 50 substances nutritives et contaminants dans le bassin supérieur des Grands lacs. Des techniques semblables d'analyse de systèmes servent actuellement à évaluer des futurs modes d'utilisation des terres dans la région.

2) Avec l'aide du ministère de l'Environnement de l'Ontario, le personnel de la Direction générale des eaux intérieures et celui du Service de la protection de l'environnement ont effectué des études sur les façons de réduire la pollution causée par les débordements des systèmes unitaires d'égout et par l'évacuation des eaux de pluie. Le principal effort de recherche a consisté en une étude donnée à contrat, et visant à mettre au point un modèle mathématique qui servira d'instrument de gestion pour l'évaluation des résultats des diverses mesures antipollution.

3) Les programmes de surveillance du bassin inférieur des Grands lacs et des chenaux de raccordement se sont poursuivis en collaboration avec le ministère de l'Environnement de l'Ontario et des organismes des États-Unis. En outre, le personnel du Laboratoire de biolimnologie des Grands lacs a mené un programme pilote de surveillance du lac Ontario afin d'évaluer le résultat des mesures antipollution sur la qualité de l'eau et sur la communauté biotique en particulier. Cette surveillance constitue un projet à long terme qui devrait normalement s'étendre au bassin supérieur des Grands lacs.

4) Le personnel du Laboratoire de biolimnologie des Grands lacs a effectué des expériences préliminaires en laboratoire au moyen de «simulateurs de colonnes lacustres» pour déterminer les effets et les possibilités de bioaccumulation des contaminants détectés dans les déchets recueillis par dragage et les eaux de ruissellement des terres agricoles. Il y a également eu des expériences conjointes avec le ministère ontarien des Ressources naturelles et d'autres organismes en vue de déterminer les effets de l'élimination des déchets dragués sur les communautés aquatiques du lac Érié (Port Stanley) et du lac Sainte-Claire (Mitchell Bay). De plus, la Direction générale des eaux intérieures a procédé à des études hydrauliques visant à déterminer le taux de dispersion des substances draguées, une fois rejetées en eaux profondes, et à des études géochimiques sur les sédiments provenant du dragage.

5) On a entrepris des projets d'étude physique, chimique et biologique afin que les objectifs de qualité de l'eau, à fixer dans le cas de la chaleur résiduaire et de certaines substances toxiques qu'énumère l'accord, puissent se fonder sur une base scientifique solide. Il faut signaler comme activité importante des études sur le terrain menées par le personnel du Laboratoire de biolimnologie des Grands lacs à la centrale thermique de Nanticoke, sur le lac Érié; ces études visaient à expliquer les relations de temps et d'espace qui existent dans le domaine de la faune et de la flore aquatiques, ainsi que les perturbations qui les affectent dans les zones de mélange causées par les effluents thermiques. Des études physiques se sont aussi déroulées à la baie du Doré et à la pointe Douglas.

6) L'élaboration du plan d'étude du groupe d'acquisition de données sur la pollution causée par l'utilisation des terres a bénéficié d'importantes contributions.

7) Des activités préparatoires ont débuté en vue de l'établissement d'une annexe sur les substances polluantes dan-

gereuses, à joindre à l'accord. La liste de 1,200 produits, classés selon un ordre décroissant du risque qu'ils représentent pour le milieu aquatique, se fonde sur les critères suivants: toxicité pour la vie aquatique; quantités employées dans l'industrie et le commerce; mode de transport et d'emmagasinage. Le travail s'est fait à contrat, sous la surveillance conjointe du personnel du Laboratoire de biolimnologie des Grands lacs et du Service de la protection de l'environnement.

8) Dans son second rapport annuel sur la qualité de l'eau des Grands lacs, la Commission mixte internationale a recommandé la réalisation de recherches sur les dangers des virus transportés par l'eau. Les scientifiques du Centre canadien des eaux intérieures ont supervisé un certain nombre d'études de virologie effectuées à contrat. Les recherches ont permis la création de techniques d'isolation et d'énumération des virus trouvés dans les eaux d'égout, les boues, les effluents et les eaux réceptrices et récréatives.

Des experts canadiens se sont rencontrés en novembre, au Centre canadien des eaux intérieures, pour discuter de la faisabilité d'une étude épidémiologique qui permettrait d'évaluer les dangers réels et virtuels que représentent pour la santé les virus logés dans l'eau. Les entretiens ont donné lieu à deux propositions d'études préliminaires visant à rattacher les infections virales à l'approvisionnement en eau et aux virus des eaux d'égout traitées et brutes.

Quelques principaux projets entrepris sur le terrain suivent.

ENQUÊTES HYDROGRAPHIQUES – DIRECTION GÉNÉRALE DES SCIENCES DE LA MER

Un relevé hydrographique couvrant la partie de l'anse Chesterfield comprise entre la baie d'Hudson et le lac Baker et mettant à contribution le système automatisé de saisie des données (HAAPS) a maintenant pris fin. Grâce à un travail mené rondement, ce programme qui devait durer deux années, a pu se dérouler en une seule. Une autre enquête hydrographique a connu de bons résultats, soit celle du chenal de l'île d'Orléans, dans le fleuve Saint-Laurent. Il s'agit d'un relevé effectué à forfait par la ComDev Marine et concernant le dragage en profondeur de la partie sud-est de l'île d'Orléans.

Un groupe de scientifiques se sont rencontrés le 26 juin 1974, à l'atelier de la baie James, pour coordonner la recherche océanographique dans la baie James. À la fin de l'année, le bureau régional du Centre avait établi un mandat pour la réalisation de levés océanographiques dans la baie d'Hudson et la baie James.

PROJET À LA BAIE DE QUINTE – LAC ONTARIO

La Direction de la recherche et du développement (Pêches), la Direction générale des eaux intérieures et les ministères ontariens des Ressources naturelles et de l'Environnement ont poursuivi un projet de recherche conjoint à la baie de Quinte. L'un des objectifs premiers de ce projet est de déterminer la réaction des biotes au programme d'élimination du phosphore entrepris en vertu de l'accord canado-américain.

Un ensemble d'enclos lacustres est maintenant en place depuis un an et demi dans la baie. Le parcours du phosphore dans l'écosystème, en direction des sédiments, a pu être tracé grâce au phosphore radioactif. La période de renouvellement dans l'enclos s'est révélée être d'une durée estimative de seulement deux minutes.

Les procédés ayant une influence sur le taux de croissance et l'abondance des algues dans les lacs ont fait l'objet de mesurages. Les expériences ont comporté des observations sur les modifications que les déversements décroissants de substances nutritives ont provoqué sur la biomasse. Des expériences sur l'alimentation ont démontré que le zooplancton peut brouter sur au-delà de 200% de plancton chaque jour.

POINTE PELÉE – LAC ÉRIÉ

Divers éléments des Directions générales des eaux intérieures et des sciences de la mer ont entrepris une étude approfondie et multidisciplinaire des rôles joués respectivement par les processus physiques, le transport de sédiments et le dragage commercial dans les pertes dues à l'érosion et constatées à la pointe Pelée. Les conséquences du dragage commercial sur les bancs de sable situés au large de pointe Pelée ont fait l'objet d'une attention particulière. Il semblerait que ces bancs soient la source de sédiments qui renforcent la côte est de la pointe. Les études des mesures des vagues ont fourni des données relatives aux processus d'accroissement à long terme par érosion, à la pointe. On a mis au point un certain nombre de techniques de télédétection qu'on a utilisées pour déterminer les phénomènes relatifs à la sédimentation et au littoral dans les alentours de pointe Pelée.

Un rapport sur la formation et l'évolution de pointe Pelée ainsi que sur les effets des opérations commerciales de dragage dans les environs est sur le point de se terminer.

PROJETS DE LA DIRECTION GÉNÉRALE DES EAUX INTÉRIEURES POUR LA ZONE EXTÉRIEURE AU BASSIN DES GRANDS LACS

Une étude physique et limnologique importante du ac Kamloops, en Colombie-Britannique, a maintenant pris son essor. Un certain nombre d'études appliquées à court erme ont aussi débuté dans diverses régions. Citons, parmi ces dernières, une étude de la formation de complexes de cuivre dans le lac Babine, en Colombie-Britannique, une étude du Petit lac des Esclaves et un apport à l'investigation imnologique d'une étude approfondie du bassin de la rivière Shubenacadie, en Nouvelle-Écosse. Le personnel a continué de participer à la planification d'une étude édérale-provinciale concernant le lac Winnipeg et a élaboré un plan provisoire.

NIVEAU ÉLEVÉ DE L'EAU DES GRANDS LACS

L'érosion et les inondations du système formé par les Grands lacs et le fleuve Saint-Laurent, tout en étant moins ortes qu'en 1973, constituent encore un problème sérieux car le niveau des lacs demeure élevé.

Le personnel de la Direction générale des eaux ntérieures et celui de la Direction générale des sciences de a mer, au Centre canadien des eaux intérieures, poursuivent es études sur l'érosion du littoral dans le cadre de l'enquête canado-ontarienne sur les dommages causés au littoral. Le rapport technique et l'atlas de la zone côtière devraient paraître vers le milieu de 1975.

MISE AU POINT D'INSTRUMENTS — DIRECTION GÉNÉRALE DES SCIENCES DE LA MER

L'élément le plus important dans ce domaine a été la création et l'application du système de traitement des données INDAPS qui permet de recueillir et de traiter sur le errain des données hydrographiques et qui a donné d'excellents résultats dans l'étude du lac Winnipeg. L'*Electronics Shop* a considérablement augmenté la force et la portée du signal du système minifix en utilisant des tours d'une hauteur de 70 pieds et des émetteurs de 100 watts. Dans le secteur océanographique, il a été possible d'effectuer la conversion de six courantomètres Aanderaa en unités C.T.P. (conductivité, température, profondeur) et de procéder à des essais de simulation dans l'Arctique.

SERVICES D'INGÉNIERIE ET DE SOUTIEN — DIRECTION GÉNÉRALE DES EAUX INTÉRIEURES

Le Service d'ingénierie a, au cours de l'année, contribué aux activités de recherche de la Direction. Les réalisations comprennent les divers points suivants: modules de télédétection contrôlée en chimie de l'eau, tours côtières pour études air-eau, systèmes programmés d'illumination pour études biologiques, appareils électroniques et mécaniques standardisés pour contrôler la température de l'eau, acquisition et essai d'un dispositif de dénombrement des poissons, conception et acquisition de canaux d'amenée pour le laboratoire d'hydraulique, dispositif spécial de carottage pour études géologiques, systèmes de contrôle à long terme de la dynamique lacustre, instruments de dispersion de la lumière sous l'eau, dispositif d'échantillonnage automatique pour la formulation de modèles pour les substances nutritives des lacs, assistance générale telle que consultations et travaux de maintenance.

Le personnel s'est également consacré à la conception finale et à la construction du système submersible REX, qui peut mesurer sur place les paramètres de la qualité de l'eau, ainsi qu'à la dernière phase du développement d'un détecteur à long terme d'oxygène dissous.

PROGRAMME DE TOXICITÉ ENVIRONNEMENTALE

Diverses espèces de poissons, d'algues et d'invertébrés benthiques ont fait l'objet d'études relatives à la toxicité du plomb et du cadmium. Les résultats préliminaires démontrent que le cadmium est plus toxique que le plomb pour les algues. Avec la collaboration des scientifiques de la Direction générale des eaux intérieures, il y a eu plusieurs expériences conjointes sur la méthylation du plomb et la bioséparation des isotopes de soufre.

FIBRES D'AMIANTE — ACCORD RELATIF À LA QUALITÉ DE L'EAU DANS LES GRANDS LACS

Au cours des dernières années, le danger virtuel que représentent les fibres d'amiante dans les approvisionnements en eau a soulevé une certaine préoccupation. Pour répondre à ce problème, le ministère de l'Environnement de l'Ontario a collaboré à plusieurs projets.

L'établissement de cartes montrant la répartition des fibres dans les lacs Supérieur et Huron, ainsi que dans leurs sédiments, a maintenant débuté. Grâce à la microscopie électronique, le personnel du Laboratoire des sciences physiques a pu déterminer les concentrations présentes dans des échantillons.

Le personnel de la Direction générale des eaux intérieures a mis au point une technique d'élimination des fibres contenues dans les réserves d'eau potable. Cette méthode permet d'éliminer 99.8% des fibres d'amiante et

peut servir virtuellement dans toutes les installations de traitement des eaux disposant de filtres à sable. La Direction générale des eaux intérieures et le ministère ontarien de l'Environnement participent actuellement à un projet conjoint qui rendra possible l'application de ce procédé à l'échelle d'une usine pilote.

CONSTRUCTION DE MODÈLES DES GRANDS LACS

Le programme de construction de modèles s'est concentré sur la simulation des niveaux, des courants, des températures et du mode de transport des particules en suspension dans les lacs Ontario et Érié. La phase hydrodynamique du projet de construction de modèles pour le lac Ontario s'est terminée en 1974 par une étude vérificative fondée sur les données physiques recueillies au cours de l'Année internationale d'études des Grands lacs.

Il y a eu conception d'un modèle informatique sur les déversements possibles de produits toxiques dans le lac Ontario. Le modèle permet de traiter un ou plusieurs paramètres tels que la concentration des produits toxiques ou le nombre d'organismes vivants.

Pour le lac Érié, les efforts ont porté sur la mise au point d'un modèle informatique conçu pour l'ensemble du lac et simulant le transport de diffusion et d'advection des substances nutritives (chlorure) en fonction du temps. Le modèle a également touché des substances telles que le phosphore.

Des travaux de cette nature se poursuivent pour le lac Ontario et visent à la conception et à la vérification de sous-modèles biochimiques utilisant les données de l'Année internationale d'études des Grands lacs (1972).

DÉVELOPPEMENT DE TECHNIQUES DE TRAITEMENT DES EAUX USÉES – SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT

C'est à *Eddy Forest Products*, Espanola (Ontario) que les services fédéraux et l'industrie ont réalisé un projet conjoint dans le cadre duquel ils ont mis en œuvre, à l'échelle pilote, un système qui traite en deux étapes et aux boues activées l'effluent produit par le blanchiment de la pâte kraft.

Le projet de recherche conjoint sur la nitrification biologique, mis sur pied par l'université McMaster en 1972, s'est poursuivi tout au long de 1974. Des études détaillées ont permis d'examiner diverses formes d'écoulement et différentes configurations de procédés.

Il y a eu poursuite de l'étude conjointe que des agents fédéraux, provinciaux et industriels avaient entreprise en 1972, en vue de développer des techniques pour traiter les eaux résiduaires des fabriques et des mines faisant partie de l'industrie des métaux non précieux. De plus, on a réalisé à la *New Brunswick Mining and Smelting Corporation*, dans le nord-est du Nouveau-Brunswick, des études à l'échelle pilote visant l'oxydation biologique des thio-sels.

Une étude concernant le recyclage des boues liquides d'eaux d'égout, effectuées sur les lits de sable des rivières draguées, en Colombie-Britannique, est maintenant terminée.

ÉVALUATION ENVIRONNEMENTALE

Depuis la récente création du Processus d'évaluation et de révision environnementales (PERE), les considérations environnementales entrent en ligne de compte dans la planification et l'exécution de tout projet auquel participe le gouvernement fédéral; de plus, les projets qui peuvent avoir des conséquences néfastes sur l'environnement sont soumis à des évaluations environnementales. Les membres du personnel du Centre canadien des eaux intérieures s'occupent de l'administration et de l'exécution du Processus en examinant les projets du point de vue des effets néfastes possibles et en donnant des conseils sur le besoin et l'orientation d'évaluations environnementales. Le personnel du Centre participe également aux études de base qu'exigent les évaluations environnementales et à l'examen des énoncés sur les incidences environnementales.

CHUTES NIAGARA DU CÔTÉ AMÉRICAIN

L'*American Falls International Board* a terminé son étude des mesures à prendre pour préserver et embellir les chutes Niagara du côté américain et a présenté son rapport final à la Commission mixte internationale. Le personnel du bureau régional de la Direction générale des eaux intérieures a contribué à cette étude.

RAPPORTS DE RECHERCHE ET CONFÉRENCES

Environ 365 documents, rédigés par le personnel du Centre canadien des eaux intérieures, ont paru dans des revues et des publications ministérielles (annexe B) au cours de 1974. M. T.J. Simons a remporté, encore une fois, le prix Chandler-Misener, décerné à l'auteur du meilleur ouvrage paru à l'Association internationale pour la recherche sur les Grands lacs.

En 1974, le Centre canadien des eaux intérieures a tenu quatre conférences importantes. En février, l

personnel du Centre de traitement des eaux usées a reçu les délégués de l'OTAN à une réunion du Comité des défis de la société moderne. Des représentants de sept pays ont assisté aux entretiens visant à définir le statut de l'usine pilote pour la démonstration du traitement des déchets par action physique et chimique; cette usine, située à Colehill Royaume-Uni), est actuellement en construction. On a choisi le Royaume-Uni comme région pilote pour ce projet alors que d'autres pays, dont le Canada, sont des régions pilotes secondaires. Au début de mars, la Direction générale des sciences de la mer, bureau régional du Centre, a organisé a 13^{e} conférence canadienne annuelle sur l'hydrographie et environ 200 personnes y ont pris part. On a tenu du 12 au 4 août, à Hamilton, la 17^{e} conférence annuelle sur la echerche dans les Grands lacs, organisée conjointement avec l'université McMaster. Le personnel a également participé au deuxième atelier sur l'accord canado-ontarien, qui a eu lieu les 18 et 19 septembre à Toronto, et dont le hème était «Manutention et élimination des boues».

RELATIONS PUBLIQUES

Dans le cadre du Programme des visites publiques, ne série de conférences données par divers scientifiques et ouvrant un large éventail de sujets a pris fin en juin après ix mois d'activités couronnées de succès. Plus de 3,200 ersonnes ont assisté à ces présentations.

Dans le courant de l'année, le programme s'est de plus n plus concentré sur un public national que régional. Cette décision a coïncidé avec l'achèvement de deux films: *Not Man's to Command* et *Second Frontier*. Grâce à la participation de l'Office national du film et des bibliothèques publiques de l'Ontario, plusieurs milliers de personnes ont pu visionner le premier film, qui traite de la régularisation et du contrôle du niveau des lacs. Le second film, qui explique le but et le travail du Centre, connaîtra une distribution nationale.

La Commission mixte internationale a également demandé l'aide de la sous-section pour organiser une série d'audiences publiques concernant la régularisation accrue du niveau de l'eau des Grands lacs.

PARTICIPATION INTERNATIONALE

En 1974, le Centre est officiellement devenu le Centre international de collaboration de l'Organisation mondiale de la santé (OMS) pour la qualité des eaux superficielles et souterraines. Le Ministère sera donc mieux placé pour conseiller efficacement les pays en voie de développement sur leurs programmes de gestion de l'eau.

Le Centre canadien des eaux intérieures continue d'agir comme meneur du programme visant à mesurer l'eutrophisation des lacs, programme instauré par l'Organisation de coopération et de développement économiques (OCDE).

Environmental Management Service

Inland Waters Directorate

HYDRAULICS DIVISION

COMMISSION

The Hydraulics Division is responsible for service and research programs in hydraulics, which are national in scope.

A national calibration service for hydrometric instruments, particularly current meters of all types, is provided. Other types of testing may also be undertaken. Tests of a calibration nature are done according to the user's specifications.

Research studies and tests are conducted directly in the Division's laboratory or indirectly by contract. Subjects of study are basic fluid dynamics, mobile boundary hydraulics, density currents, ice and cold weather hydraulics, wave dynamics erosion, coastal engineering and urban hydraulics. The aims are to establish by systematic studies a thorough understanding of natural hydraulics processes, to provide estimates of the changes in regime caused by land and water developments, and to seek the most effective development practices and design methods that will reduce undesirable environmental changes.

RESEARCH PROGRAMS

River Systems and Fluid Mechanics

Dispersion of Dredged Material Dumped in Deep Water

Experiments were carried out in an observation tank in the Hydraulics Laboratory to study the dispersal of the granular material released as a slug from the water surface. The results of the experiments show that the motion of the particles can be treated in two distinct phases, namely the initial "entrainment" phase and the final "settling" phase. During the entrainment phase the size of the "cloud" grows because of the incorporation of the external fluid, while the vertical downward velocity diminishes. During the settling phase, when the vertical downward velocity is the same as the fall velocity of the individual solid particles constituting the cloud, the increase in the cloud size is solely due to ambient turbulence. Based on these results, a method has been proposed to predict the vertical height and the horizontal size of the "mound" formed from the deposition of the dredged material at the bottom of the deep water. The parameters governing the characteristics of the mound are 1) the volume of the dump, 2) the size distribution of the dredged material, 3) the height of the deep water, and 4) the ambient current. This method is useful for providing guidance for the selection of optimum dump size and the location for the disposal of the dredged material.

Dispersion in Meandering Channels

The transverse dispersion processes in natural rivers are being studied in the Hydraulics Laboratory with the aid of laboratory channels having different meandering configurations. The experiments performed indicate that the transverse dispersion coefficient increases with the growth of the amplitude of meander. A unique feature of the present experiments is that the bed of the channel is covered with sand and the bed forms are scoured by the flow itself, so that the flow conditions are as close to nature as possible.

Fall Velocity of Solid Particles of Different Shapes

The measurement of fall velocity of solid particles of various shapes, e.g., cubes, parallelepipeds, spheres, cylinders, and discs, is undertaken at the Hydraulics Laboratory. The results of the measurements made indicate that the fall velocity of sand particles moving in water is independent of the particle shape, as long as the size of the particle is less than 0.250 mm.

Diffusion Coefficients in Rivers

There have been wide variations in published values of the transverse diffusion coefficient, and it is suspected that these variations are caused by differences in the width to depth ratios of the channels and their friction factors. Systematic experiments are underway to resolve the problem.

Evaporation in Rivers

Owing to the lack of a method of measuring evaporation from flowing water, a study of the feasibility of using radioactive tracers for such measurements was started.

Some base-line experiments without tracers were performed in a small wind tunnel, and measurements with tracers will begin shortly.

Flow Criteria for Oil Boom Design

A review of the criteria for containment of oil slicks in rivers by using booms was completed. It revealed that all but one of the proposed theories had serious flaws. It was concluded that some experimental work was necessary before oil containment criteria and strategy could be established in practical situations. Experiments have begun in a tilting flume.

Mobile Boundary Studies

Hydrophone Technique

The feasibility study was continued for the detection and measurement of bed-load transport in rivers. Extensive field observations were carried out in the Vedder and Fraser Rivers in British Columbia during the 1974 spring runoff. Approximately four hours of sound recordings were successfully obtained during periods of bed-load transport, as verified by conventional sampling. Recorded data have been analyzed for spectral characteristics to identify the sediment noise from the background noise in the rivers. Acoustic noise, generated by collisions among the moving and the stationary bed particles, was simulated under ideal conditions in the laboratory. The results, indicative of the nature of sound generated by particle collisions and of the acoustic transmission characteristics between the source and receiver, were employed in the development of a theoretical transfer function relating the rates of bed-load transport with measured sound pressure levels. The theoretical analysis of an idealized system, which considered the multiple particle collision sources and their range to an omnidirectional receiver, showed that the measurement of sound pressure levels at a known distance from the river bed is not sufficient to establish the rate of bed-load movement. Furthermore, the acoustic method has no merit if bed particles saltate. The analysis indicated, however, that the technique may be feasible with the use of directional hydrophones and independent determination of the acoustic power generated by individual collisions. The project will be completed in early 1975.

Hydrographic Technique

A study to establish field measurement criteria for the determination of bed-load transport from repeated surveys of the movement and geometry of sand dunes in large rivers has been initiated in the laboratory. The instrument carriage of the two-metre sediment flume has a constant speed drive system. Procurement of equipment for automatic observation and recording of bed-form geometry and water levels has been completed during the year. Experiments will commence and continue througho 1975.

Initiation of Sediment Motion

In support of dredging studies for the Canada-Unit States Water Quality Agreement, a compendium on initi tion of sediment motion data has been completed und contract by a consultant. Specifications were also prepare and a contract was awarded to consultants for a co prehensive report on the engineering aspects of the cess tion of motion phenomenon and its relevance in the contr of sediments in dredged channels.

Urban Water Systems

Several studies have been undertaken in support the Canada-United States Water Quality Agreement wi respect to reducing pollution caused by uncontrolled sto water discharges and combined sewer overflows. A contra study to assess the existing urban runoff models, which w commissioned to a consultant by the Hydraulics Divisio has been completed. The Storm Water Management Mo of the United States Environmental Protection Agenc identified as the most versatile and comprehensive mod was recommended for further use and modification. M of these modifications will be implemented in a curre study of the development of a Canadian version of t Storm Water Management Model. This study also invol two other government agencies, the Environmental Prot tion Service (EPS) and the Ministry of the Environme (MOE) and is being done in close co-operation with tv consulting engineering companies. The need for mo modification was motivated by the necessity to account f Canadian climate, economy, engineering practices a environmental concerns. It was realized in the early stage the current research program that there was an urgent ne for accurate data on runoff and overflow quantity, qual and frequency. Further advancement of the study of run modelling is presently impaired by the lack of adequa data. Consequently, the Hydraulics Division has continu and expanded the data collection program. Besides t established test area in Burlington, three other test ar were instrumented in Burlington, Hamilton and Toronto.

Both Burlington areas are served by separate sew one site is a residential development, the other site i commercial plaza. An example of an observed and co puter-simulated runoff event on the former area is sho in Figure 1. The Toronto area is operated by a consulta Data collection will concentrate on monitoring the quant and quality of runoff during the snowmelt period. T Hamilton area is served by combined sewers and will very valuable in assessing the pollution loads from co bined sewer overflows. So far, the entire research progr has created considerable interest among consulting a

municipal engineers, and some results of this research are already being implemented. The models under development will also serve government agencies in assessing pollution originating on urban watersheds.

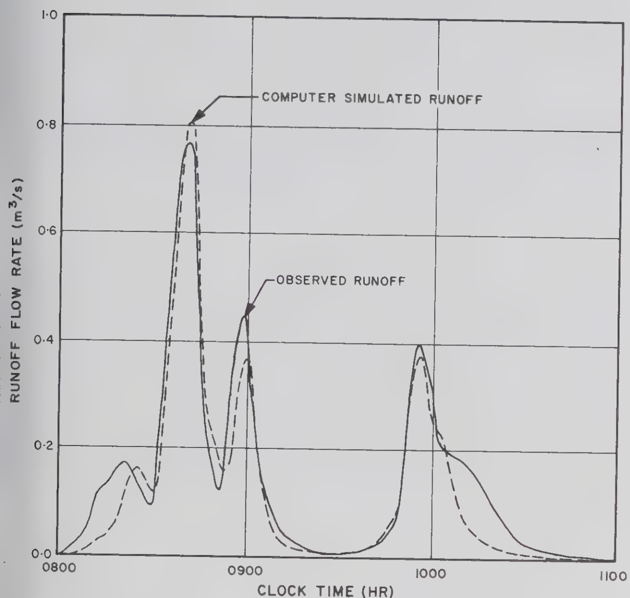


Figure 1. Observed and simulated runoff on Burlington test area.

ce Studies

Cold Rooms

During 1974, experimental cold rooms were com- ɔleted. One of these rooms will be used for scientific ;tudies. A unique feature of the facility is that the system equires no defrosting cycle. At present, apparatus for ɔreliminary testing of frazil ice production is installed.

ce Piling on Shores

In 1974, the field projects concerning ice piling on ake shores and the friction loss of ice-covered rivers were ompleted. For the ice-piling project, the meteorological, imnological and ice parameters were simultaneously ecorded at the Lake Simcoe site. The study confirmed revious work that ice piling is an activity of short luration. The change of wind direction from offshore to nshore is the primary cause of ice piling.

riction of Ice Cover

For the study of friction loss because of ice cover, oth winter and summer data have been collected from the hree sites on the Grand River in Ontario. Preliminary nalysis showed that the hydraulic gradient of a river emains the same under both open water and ice-covered onditions.

Frazil Ice

A project to study the formation of frazil ice in water with surface waves was initiated, and preliminary experimental equipment was set up.

St. Clair-Detroit River Studies

Studies on the ice conditions on the St. Clair and Detroit Rivers and the containment and recovery of spilled oil from the two rivers under winter conditions have also been conducted. The studies showed the necessity of measures for winter oil spill control and that ice and oil can be contained and possibly separated by specially designed booms that are properly deployed.

Environmental Flume

To study the winter flow conditions in a controlled environment, an environmental recirculation flume with a wind tunnel has been designed and is under construction. The completion date is expected to be in the spring of 1975.

Coastal Systems

Wind-Wave Flume

During 1974, all of the major equipment for the wind-wave flume was installed. Although all of the components were not yet fully commissioned, work had advanced sufficiently to conduct the first large test. This test was the design evaluation of a rubble mound breakwater, armoured with dolos units, proposed for a new harbour at Grande Baie, Newfoundland. The test was done for the Department of Public Works. Two important results of the test were 1) larger armour units than initially proposed would be required to withstand the maximum design storm and 2) construction procedures were established to minimize erosion of the small core material from typical summer storms. A view of the flume is shown in Figure 2.

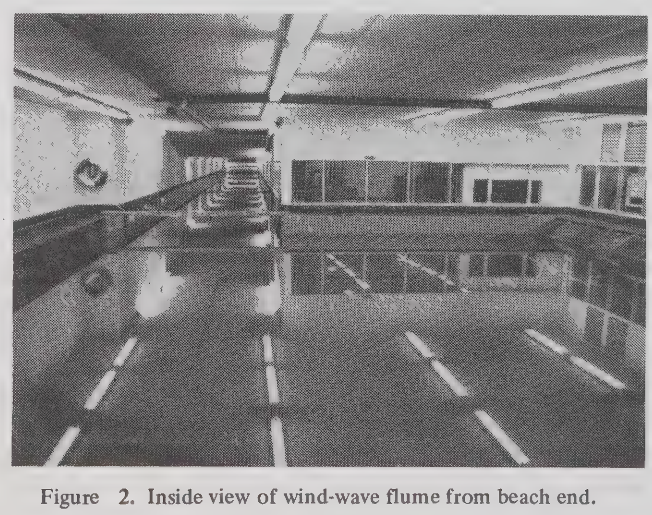


Figure 2. Inside view of wind-wave flume from beach end.

Point Pelee Studies

Problems of erosion have developed along the shore of Point Pelee National Park. As part of CCIW's effort to understand and document these problems, waves were measured off both sides of the Point throughout the 1974 field season. The problem of successfully mooring Waverider buoys in relatively shallow water, encountered in previous years, occurred again at Point Pelee, resulting in the loss of one Waverider. Otherwise the measurement program was successful and provided valuable wave data for the other field project carried out concurrently.

Work started in 1974 to estimate the net littoral drift at Point Pelee. The approach being used is to establish the frequency of occurrence of wave heights and directions off the Point from wind climate data. Numerical methods are then employed to route the wave energy with the near-shore zone. Empirical relations between wave energy in the breaker zone and littoral drift are then used to establish the net drift. It is hoped that this project will produce significant data on the long-term erosion-accretion processes at Point Pelee.

SERVICE PROGRAMS

Hydrometric Service

National Calibration of Current Meters

A brochure entitled "Current Meter Calibration" was prepared and distributed. During 1974, 703 current meters were calibrated, ranging from simple streamflow meters, such as the Ott and Price, to more elaborate types for lake and ocean surveys, such as the Geodyne, Plessey or Aanderaa (Table 1).

Table 1. Meter Distribution

Agency	Number of meters
Water Survey of Canada	382
CCIW	120
Other federal agencies	35
Provincial agencies	124
Universities	28
Private sector	14
	703

Low Temperature Testing

There is a need to test and evaluate existing instrument packages, such as recorders, under simulated cold climate conditions to ensure success in recording data under harsh environmental conditions. For this reason a torture-testing cold room was constructed and will be fully developed in 1975.

Various Engineering Studies

Culvert Design for Fish Passage

A hydraulic model study was completed to establish designs for fish passage facilities in highway culverts on the Mackenzie Highway. These designs should aid the passage of fish through culverts with slopes of up to 5%.

Weir Calibration

A second model study was completed to provide a stage-discharge curve for a composite weir operated in a research basin at Perch Lake near Chalk River, Ontario, by Water Survey of Canada for Atomic Energy of Canada Ltd. The model was built to a scale ratio of 1:2 and provided results well within prototype accuracy. Observations were made regarding the sensitivity of the weir and the erro[r] that could be incurred with the prototype design.

Technical Services

The function of Technical Services is to provid[e] assistance to the scientists and engineers of the Division. The responsibility also extends to the general upkeep of th[e] laboratory and the maintenance and operation of majo[r] installations, such as the one-metre and two-metre flumes, the pumping stations, the sediment-handling equipment, the recently completed wind-wave flume and the col[d] rooms.

Technical support is provided by seven hydraulic technicians who are assigned to projects under the guidanc[e] of the engineer or scientist in charge. Their tasks involv[e] setting up experiments; collecting, evaluating and analyzin[g] data; designing; plotting graphs; and writing reports.

Support is also provided by a "light" machine sho[p] where repairs are made and specialized small parts ar[e] manufactured for experiments. Work of a complicated o[r] non-urgent nature is done by the Central Machine Shop o[r] is contracted out. A full-time carpenter joined the Un[it] early in the year.

The electronics service shop responds to the mai[n]tenance and set-up needs in the laboratory.

LAKES RESEARCH DIVISION

The objective of the Lakes Research Division, in the broad terms of reference of Environment Canada and the Environmental Management Service, is to provide th[e] government with the scientific knowledge for managing th[e]

freshwater resources of Canadian lakes.

The Division has two essential functions: 1) to perform basic research to increase scientific knowledge in the field of limnology, i.e., the science of lakes and lake behaviour or processes and 2) to deliver scientific tools needed by management to solve present and future environmental problems related to lakes.

During 1974, the organization of the Division remained ostensibly the same as during the previous year, although changes were made that were expected to make the best use of existing and limited manpower and to simplify reporting relationships. The Lakes Resources Subdivision was re-named the Applied Limnology and Physical Processes Section and was formulated to include an Applied Limnology Unit, a Physical Processes Unit and a Systems Modelling Unit. The remainder of the Division was incorporated into a Sedimentary and Chemical Processes Section with four Units covering sedimentology, geochemistry, nutrient dynamics and toxic substances.

The Pacific Region detachment and the Prairie and Northern Region detachment continued to receive scientific guidance for their programs, although line management responsibilities were transferred to the new regional structure of the Environmental Management Service. The Palaeoenvironmental Research group of the Water Resources Branch became closely associated with this Division's activities during 1974 and will be completely integrated in the 1975 program.

During 1974, the primary concerns of the Division have been studies related to the Canada-United States Agreement on Great Lakes Water Quality. In addition, a major research study was centred on Kamloops Lake in British Columbia. A number of short-term applied studies were also undertaken in several other regions of the country, e.g., Lesser Slave Lake, copper complexation in Sabine Lake, a specific study of the southeast bend cutoff in Lake St. Clair, and the Shubenacadie Lakes Project.

APPLIED LIMNOLOGY AND PHYSICAL PROCESSES SECTION

The Applied Limnology and Physical Processes Section undertakes and coordinates multidisciplinary lake studies in support of IJC Reference Groups, federal-provincial agreements under the Canada Water Act, the Great Lakes Water Quality Agreement and support of regional requirements supplemental to the work of CCIW groups already established in the Regions. As the latter part of the name implies, basic research in the field of physical limnology is also carried out within the Section to increase scientific knowledge of lake processes.

A strong link between these two general activities and the research of other units is present in the development of computer modelling. The modelling effort, originating in the study of lake hydrodynamics, has moved to verification of its ability to simulate water levels, currents and temperatures for Lake Ontario, based on data collected in 1972, as a part of the International Field Year for the Great Lakes. With the computation of the three-dimensional water circulation, the next step will be directed toward development and verification of biochemical submodels. With these same computations, the modelling of toxicant spills has been undertaken as well.

The work of the Section is strongly (although not exclusively) centred on the Great Lakes large lake systems. The modelling studies mentioned, up to now, pertain to Lake Ontario. The results of a hydrodynamic model for Lake Erie have also been tested against 1970 data for the distributions of a conservative and a non-conservative material (chloride and phosphorus) with the "fitting" of the model centred on the choice of a suitable horizontal eddy diffusion coefficient. The coefficient so fitted gave a similar range to that determined in dye studies.

The other approach taken in the Section for lake-wide studies is the descriptive lake-assessment technique characteristic of the Applied Limnology group. The primary field effort in this direction in 1974 consisted of open-lake research surveys of Georgian Bay and Lake Huron in support of the IJC Upper Lakes Reference Group. Staff were also involved in the planning and analysis of data collection programs from less intensive surveys carried out in Lakes Ontario and Erie in support of surveillance and surveillance design studies. Open-lake survey efforts consist of sampling programs for physical, biological, geological, chemical (including toxic substances) and microbiological parameters. As such, they are co-operative programs planned by the scientific staff of the Lakes Research Division, the Great Lakes Biolimnology Laboratory and the Scientific Operations Division, with technical operations assistance from the Scientific Operations Division and analytical services from the Great Lakes Water Quality Laboratory of the Water Quality Branch. Coordination with Ontario agencies and United States federal and state agencies is effected through the working groups of the Upper Great Lakes Reference Group.

Parallel with these survey programs, analysis progresses on current and past data. These analyses for the upper Great Lakes are directed toward the definition of base-line conditions, the identification of major water masses and their movement through the lakes, the description of the interrelations between physical, biological and chemical parameters, the identification of the principal processes governing open-lake water quality conditions, and the study of the trends in water quality for these lakes.

The analysis for trends and the continuing assessment of lake conditions extend to the lower Great Lakes in a program of surveillance research, including water quality conditions and lake circulation climatology.

A major and somewhat separate component of the IJC Upper Great Lakes Study concerns atmospheric loading as a significant source of materials with respect to water quality. The program is directed from CCIW with the Lakes Research Division and the Water Quality Branch in leading roles. The program consists of an extensive sampling network of both a routine and experimental nature, and a numerical atmospheric deposition model. Co-operating agencies include the Atmospheric Environment Service, the Ontario Ministry of the Environment, the United States Environmental Protection Agency and the Michigan Water Resources Commission. Portions of the program are conducted under contract with Acres Consulting Services and Earth Sciences Consultants.

In support of studies to meet the needs expressed in the Canada-United States Water Quality Agreement, an investigation was completed jointly through contract with Acres Consulting Services to establish existing and future water loss because of evaporation produced by waste heat being injected into Great Lakes waters.

Both the Applied Limnology and Physical Processes groups are engaged in additional studies pertaining to waste heat disposal. These include an assessment of near-shore temperature climatology and an investigation of near-shore physical processes that produce differing onshore-offshore exchange regimes.

The basic research of the Physical Processes group in the past year has been directed, in large part, to the Great Lakes. Much of the research relates to the analysis of the data collected in the International Field Year for the Great Lakes. Studies extend to investigation of vertical transfers of heat in relation to wind stress, thermal structure and velocity profiles, heat stored in Lake Ontario, definition of the thermocline and internal waves.

Tidal generation processes have been investigated with particular attention to Lake Ontario where earth tide effects are also evident.

Air-water interaction studies relating profile measurements to flux measurements over a wide range of stability conditions have been reported and are still under investigation. The work assists the lake-wide assessments of heat, momentum and moisture fluxes required for the comprehensive IFYGL studies; work has also been carried out on the scale of the size of thermal plumes to establish the relative importance of heat transfer to the atmosphere and to ambient waters in the dissipation of heat discharged from power plant condensers.

Turbulent diffusion studies, conducted in the field under widely varying environmental conditions, have demonstrated the dependence of turbulent eddy diffusivitie on observed environmental parameters in a form useful fo modelling practical diffusion problems.

Basic studies pertaining to coastal dynamic processes such as upwelling, downwelling, transport and dispersal i the coastal zone, have also been undertaken.

Small lakes systems have come under investigation i all three groups of the Section. An analytical model o upwelling for a mountain lake has demonstrated th behaviour of the thermocline for this type of situation. Th thermal structure and circulation of Kamloops Lake, B.C. have been under study, in support of the program of th Pacific detachment of CCIW. Finally, a staff member of th Applied Limnology Unit assisted in the limnological aspect of a study of the Shubenacadie River basin. This study wa a co-operative effort between the Inland Waters Directorat and the Province of Nova Scotia and was directed towar determination of the impact of land use on water quality About 20 lakes form elements of this basin, demonstratin a wide spectrum of impact.

SEDIMENTARY AND CHEMICAL PROCESSES SECTIO

The Sedimentary and Chemical Processes Section o the Lakes Research Division was formed during 1974 with mandate to investigate chemical and geological lacustrin processes. The Section is composed of four Units.

Sedimentary Processes Unit

The Sedimentary Processes Unit was established t carry out research on the processes controlling the disper sion and deposition of sediments in lake systems, both i the near-shore and offshore lake environment; to stud problems associated with shoreline erosion, littoral tran port, siltation and beach and bar formation; to determin the mechanisms controlling sediment-sorting (includin turbulent reworking), insofar as the textural properties ar related to the geochemical characteristics of the sedimen with associated uptake and release of nutrient and toxi elements.

Geochemistry Unit

The Geochemistry Unit was formed to condu research leading to an understanding of the geochemic cycles of inorganic and organic compounds at the sed ment-water interface and in buried sediments; to evalua

the regional distribution of elements in lake systems; and to evaluate mass geochemical budgets.

Toxic Substances Unit

The Toxic Substances Unit was established to examine the occurrence and movement of refractory organic material in the aquatic environment. (Here refractory refers to material that is not readily degraded in open waters.) Such material persists and is potentially biomagnified to the degree at which it may become deleterious to the environment. Of particular concern is the lower molecular weight fraction, usually neutral, which is introduced by man.

Nutrient Dynamics Unit

The Nutrient Dynamics Unit was formed to conduct research on the pathways of nutrients (P, C and N) in the lacustrine system; it includes measurements of primary productivity and algal standing crop as a function of nutrient availability, sedimentation and decomposition (heterotrophic activity), zooplankton-grazing, uptake and release rates of P, C and N compounds and release of nutrients from the sediments.

Paleoecology Unit

The Paleoecology Unit was established to conduct a systematic sampling program of Canadian fresh waters for shelled invertebrates to facilitate the interpretation of the paleoclimatology of Canada for the past 2000 to 3000 years. These recorded data are also being used to determine an index of the aging process of lakes.

NEAR-SHORE SEDIMENT STUDIES

In 1974, the mapping of the Lake Erie near-shore zone was extended from Port Glasgow to Point Pelee.

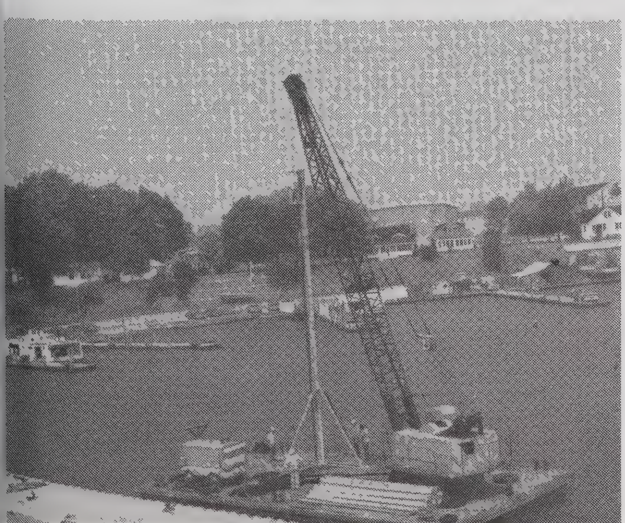


Figure 3. Assembly of the Vibracore sampler, Kingsville Harbour.

Jetting measurements of sediment thickness were continued in Lake Erie with surveys of near-shore deposits between Long Point and Point Pelee. Coring operations based on the Beachcor hydraulic corer were completed in Lake Ontario with surveys at Toronto and Brighton. Under contract, cores collected during the 1973 surveys have now been analyzed for pollen content. Results indicate that pollen-dating is applicable to sandy near-shore sediments, providing the silt content exceeds 10%.

Tracer studies based on an acoustic "pebble" are now in progress, as part of a study to measure the mobility of near-shore sediments in the pebble-size to boulder-size range.

CANADA-ONTARIO SHORE DAMAGE SURVEY

Regional Survey of Long-Term Recession Rates

Due to the predominance of bedrock-protected shorelines in the upper reaches of the Great Lakes, the survey was confined to more than 2000 km of the erodable shoreline extending from Port Severn (Georgian Bay) to Gananoque (Lake Ontario). A total of 703 recession measurements corresponding to intervals of approximately 30 years were collected using data previously published, supplementary data collected in 1973, and the precise comparison of shoreline points on aerial photographs taken in the 1950's and in 1973. The data from aerial photography were analyzed by means of digitized cross sections and were valuable in highlighting recession related to a high-low-high lake stage sequence. These data also complemented the data on recent erosion (since 1970) collected by the Shore Properties Section of the Marine Sciences Directorate.

In-depth interpretation of the results of the survey are included in the Coastal Zone Atlas and the Technical Survey Report to be released in early 1975.

Point Pelee Studies

A comprehensive, multidisciplinary investigation of the respective roles of physical processes, sediment transport and commercial dredging on the continuing erosion losses at Point Pelee was launched in 1974 by personnel from the Lakes Research Division, the Scientific Operations Division, the Hydraulics Division and the Marine Sciences Directorate. A contract study by staff of the University of Windsor also supplied data on the effect of winter ice conditions on beach erosion.

Seven long cores were collected over the Point Pelee shoal using a 40-foot long vibratory sampler (Vibracore) supplied by Alpine Geophysical Associates, Inc., of Norwood, New Jersey (Fig. 3). Detailed core logs have

been prepared to determine main sedimentary units and their stratigraphic sequence. Field and laboratory data, including radiocarbon dating, will be used for the interpretation of depositional history of the study area.

PLEISTOCENE AND HOLOCENE STRATIGRAPHY OF THE LAURENTIAN GREAT LAKES

A detailed study was made of the stratigraphy of unconsolidated sediments in northern Lake Superior (north of latitude 48°) by means of echo-sounding and coring. Although in recent years many investigations of sediments in Lake Superior have been conducted, details of the northern part of the lake have remained incomplete because of the necessity of taking very long cores to penetrate the complete late-glacial and postglacial sequence. Over 80 piston, gravity and benthos cores ranging in lengths of up to 18 m were collected and studied.

A study of the palynology, stratigraphy and mineralogy of a long sediment core from South Bay, Lake Huron, is underway. The occurrence of well-formed pyrite nodules associated with organic matter in this core is noteworthy. Although generally a rare mineral in the Great Lakes, pyrite may have formed in this sediment because of the presence of sufficient sulphur, which was possibly introduced in sulphate-bearing groundwater.

TASK FORCE 8

In February, subsurface investigation was carried out at the site of a trial dredgings disposal area in Lake St. Clair near Mitchell Bay, Ontario. The investigation involved the coring and continuous sampling of the recent and Pleistocene deposits down to the bedrock level. A series of sedimentological, geotechnical and geochemical tests were performed later in the year to determine dredge spoil and lake-bed sediment conditions at the site.

A series of laboratory physico-chemical tests were conducted on representative samples of sediment from the lower Great Lakes to determine changes which take place in dredge spoil material during land disposal. The tests showed that drying and oxidation increased the cation exchange capacity and decreased the plasticity of recent fine-grained sediments, whereas in the case of the Pleistocene sediments these properties remained unchanged. The study will continue in 1975 with a subsurface coring investigation at the Toledo Island disposal site where the dredge spoil material has been exposed to groundwater percolation and sub-aerial processes from 7 to 14 years.

PALYNOLOGICAL AND GEOLOGICAL STUDIES BY THE GEOLOGICAL SURVEY OF CANADA DETACHMENT

Sediment descriptions, photography and x-ray radiography were completed on all piston and gravity cores that had been collected from Lakes Ontario, Erie, Huron, and Georgian Bay prior to 1974. The Lake Ontario data enabled the compilation of a postglacial sediment thickness map and stratigraphic cross sections of the basin sediments. An immediate use for this information is as support data for a geological map of Lake Ontario under preparation by GSC personnel, Ottawa, for IFYGL.

Acoustic-profiling and coring cruises were carried out on Georgian Bay and Lakes Erie and Ontario. Sediment velocity and thickness data were obtained on the Georgian Bay cruise so that proper interpretations could be carried out on the echogram and seismic reflection data already available. A total of 30 long piston, 7 (6 m) gravity and 70 benthos (1 m) cores were taken at selected areas throughout Lakes Ontario and Erie in an effort to solve some specific problems of stratigraphy, sediment distribution and bottom configuration.

Table 2. Annual Natural and Anthropogenic Inputs of Heavy Metals and Nutrients to the Sediments of Lakes Huron, Erie and Ontario (metric tons per year)

Element	Lake Huron		Lake Erie		Lake Ontario	
	Anthropogenic	Natural	Anthropogenic	Natural	Anthropogenic	Natural
Hg	0.30	0.48	11.7	5.0	12.6	0.5
Pb	430	90	3,230	900	1,090	125
Zn	500	285	7,815	3,750	2,380	435
Cd	3	4	88	42	23	5
Cu	100	135	965	1,140	310	190
Cr	85	165	4,450	1,830	550	420
Ni	170	190	2,010	2,000	405	600
Org-C	35,400	123,900	794,000	478,000	188,000	88,000
N	4,880	16,600	114,000	57,200	25,100	9,710
P	1,340	3,410	18,600	32,200	5,120	3,900

Pollen horizon determinations were continued on long cores from central Lake Erie. The pollen horizons ere dated by correlation with other radiocarbon-dated rofiles in the Lake Erie basin, and thus provide chronologic ontrol for paleomagnetic and isotope studies on these ores by Professor K. Creer, University of Edinburgh, nited Kingdom, and Professor P. Fritz, University of 'aterloo, respectively. The results of these studies are onsistent with and complement the pollen and sedimen-ological data, increasing our knowledge of the late-uaternary history of Lake Erie.

Studies on the paleoecology and Holocene chronol-gy of buried plant detritus beds were expanded in the reat Lakes. Six radiocarbon dates were obtained on plant etritus in Lake Huron sediments. Plant macrofossils, ollen, insect remains, molluscs, and ostracodes were ex-acted from the detritus and identified. Pollen analyses ere commenced, and radiocarbon dating was carried out ı cores containing plant detritus from embayment sites in ıke Ontario and Georgian Bay.

Ambrosia (ragweed) and *Castanea* (chestnut) pollen ›rizon determinations for estimating recent sedimentation tes were completed on approximately 50 cores from Lake ıtario by Lakes Research Division staff in co-operation th the Geological Survey of Canada.

GEOCHEMICAL INPUTS TO GREAT LAKES SEDIMENTS

Trace elements and nutrients were determined for core locations, representing basins of fine-grained sedi-ent in Lakes Ontario, Erie and Huron. The concentrations Hg, Pb, Zn, Cd, Cu, Cr and Ni are enriched in the surface diments relative to base-line concentrations below the *nbrosia* horizon ($\sim$ 120 years BP). The enrichment of the avy metals is related to the increasing anthropogenic ıding of these elements in recent years. Enrichments are ıch greater in Lakes Ontario and Erie, which have large lustrial cities in their drainage basins, than for Lake ıron with its lesser urban population. Surface sediment ncentrations of the elements in Lake Ontario are similar those of suspended sediment samples from river mouths ›und Lake Ontario, whereas the base-line values in the liment match those of glacial tills around the lake. trient elements (organic carbon, N and P) have similar ıracteristics to the heavy metals reflecting the increasing :hropogenic loading of P to the lakes with commensurate reases in primary productivity.

Preliminary estimates of the anthropogenic and nat-l inputs of the heavy metals and nutrients to the shore sediments are shown in Table 2. The estimates clearly show the impact of human activities in the three lakes. The anthropogenic inputs parallel the populations of the three drainage basins and also reflect the heavy industry of the Lake Ontario and Lake Erie basins.

It is not possible to pinpoint the sources and dispersion pathways of the anthropogenic inputs. There is evidence that atmospheric inputs are an important source of heavy metals and nitrogen to the lake sediments, accounting for all the anthropogenic load of these elements to northern Lake Huron. The anthropogenic elements are mainly deposited in the downstream location in each lake, a considerable distance from the primary source areas. The statistical relationship of the heavy metals to the organic matter indicates that part of the heavy metal input to the lakes is incorporated into the food chains and is sedimented with the particulate organic matter. The large quantities of fly ash in the sediment suggest that part of the heavy metal input originates from fossil fuel consumption in the region.

STABLE ISOTOPE VARIATIONS APPLIED TO POLLUTION STUDIES

The studies on the use of $^{34}S/^{32}S$, $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios as tracers to determine the sources and behaviour of certain pollutants in lake environment were continued. The applicability and limitations of sulphur isotopic variations as source indicators in the lower Great Lakes are typefied by the data for Lake Erie shown in Table 3. The most notable feature of the data is that the mean $\delta^{34}S$ values of the various sources and sinks are different. Potentially it is thus possible to use the isotope ratio differences to determine the sources of sulphur in the waters of the lake and the mixing patterns of the various masses of water in the lake.

Table 3. Mass and Isotopic Balance for Sulphur in Lake Erie

Source/sink	$SO_4 \times 10^{10}$ g	Mean $\delta^{34}S$(‰)
Detroit River (L. Huron outflow)	267.8	+6.4
Runoff, all sources	110.1	+4.8
Precipitation onto lake's surface	16.3	+6.0
Sewage and other industrial discharges	58.7	+2.2 (estimated)
Total input	452.9	+5.4
Outflow, Niagara River	424.2	+5.2
Outflow, Welland Canal	14.6	+5.2
Total outflow	438.8	+5.2
Lake Erie: western basin	50.2	+6.4
central basin	649.3	+5.2
eastern basin	353.1	+5.2
Organic matter pool in lake water	0.426	same as lake water
Total in lake water	1,053	–

TOXIC SUBSTANCES

Studies in this group centred on three major topics in fields related to toxic materials: identification of organics, fate of toxicants and metal relationships.

Under organic identification, gas chromatography—mass spectrometry (GC—MS), was employed to identify Mirex, a $C_{10}H_{12}$ compound, in fish samples from the Bay of Quinte. The major effort under the identification program involved a study at a kraft process pulp mill at Red Rock, Ontario. Dye was used to follow the effluent plume, and samples have been obtained from the discharge, the discrete plume over time, and water, seston, sediment and biota forms from outside the plume. These are all to be examined employing GC—MS. In addition, the problem of fish-fainting is being examined to identify causative compounds.

Several problems concerning the fate of toxicants were examined. Biodegradation of three non-ionic surfactants under both laboratory and field conditions showed 90% degradation in approximately three weeks. The relationships of water soluble components of oils and the aquatic environment were undertaken during the latter part of the year, while the evaluation of oil herders was continued. A study of the feasibility of using water-solvent partitioning as an index for likely bioaccumulation at the phytoplankton level was initiated.

The relationships between metal complexing capacity and primary productivity, chlorophyll *a*, bacterial numbers and respiration were examined for a synthetic medium. The ability of various sediments to biologically methylate lead (yielding Me_4Pb) was demonstrated, and similar work is being undertaken with selenium. The rate of loss to air and the forms of mercury in dredged sediments were also investigated.

NUTRIENT DYNAMICS

The measurements of the rate processes that influence the growth rate and abundance of algae in lakes were completed in the Bay of Quinte. These experiments included changes in biomass that result from decreased nutrient-loading. The quality and degree of light penetration were considerably increased, but many traditional limnological methods failed to detect any improvement. Dynamic models are being constructed using data obtained from transport measurements of radioisotopes $^{32}P\text{-}PO_4$ and $^{14}C\text{-}HCO_3$ that were added to "limnocorrals," enclosures measuring 25 square metres, in water 4 metres deep. Some other interesting aspects of the study were measurements of atmospheric contribution, i.e., nitrogen fixation, carbon dioxide invasion, and nutrients in precipitation.

The movement to the sediments was calculated using both mass balances of radioisotopes and sediment traps. The latter method was found to be particularly useful in defining the important transport pathways to the sediments. An index was developed for corrections for sediment resuspension owing to wind-induced turbulence. This can be applied to most lake systems. Many myths concerning phosphorus regeneration during winter months were exposed, and factors that influence internal loading from sediments with an oxidized microzone were discovered.

The determination of adenosine triphosphate (ATP content of the planktonic organisms within the limnocorral was continued. This provides an estimate of total livin biomass and, when combined with total particulate carbor and chlorophyll, can be used to categorize a community into relative importance of autotrophic and heterotrophi organisms, plus the abundance of dead particulate material Two of the basic problems associated with biomass deter minations via ATP are 1) the separation of algal an bacterial biomass after the removal of zooplankton an 2) the variation of ATP content in certain organisms unde different nutrition conditions. A preliminary study ha shown the majority (83%) of the bacteria passes through one-micron Nuclepore membrane filter, while all recognize algal species are retained. ATP determination can then b made on these two fractions. Millipore filters cannot b used for size fractionation. The second problem is currentl under investigation, and it is proposed that the dete mination of the sum of the adenosine nucleotides (AM ADP and ATP) will reflect biomass changes better tha ATP alone.

Research is progressing on the purification of a hig molecular weight ($> 10^6$) polysaccharide isolated from th dissolved organic carbon fraction of limnocorral no. surface water. This polysaccharide is composed of galacto and xylose units and is believed to be of algal origin. Th structure, biodegradability, and chelating properties of th compound will be investigated.

Although zooplankton represent a small fraction the total biomass of a lake (1.5%), they are extreme important in nutrient regeneration. They eat an amou equivalent to 1/10 to 4 times the entire algal and bacteri biomass each day.

MULTICOMPONENT BRINES

Vapour pressure measurements have been complet for the system $H_2O - NaCl - Na_2SO_4 - MgCl_2 - MgS$ at 298.15 K and at any composition. Other studies a underway on the thermodynamic properties (includi solubilities) of relatively soluble phosphate minerals and naturally occurring metal-organic compounds.

SCIENTIFIC OPERATIONS DIVISION

The Scientific Operations Division (SOD) consists of e Sections: Microbiology, Physical Sciences Labora-ies, Technical Operations, Remote Sensing, and Data nagement. Its functions are

1) providing services to many or virtually all of the other scientific organizations at CCIW,
2) conducting research and development studies related to the methodology of each Section, and
3) conducting or participating in environmental research projects related to the specialization of each Section.

In addition, through the office of the Division Chief, re is considerable involvement in the planning and ection of multi-agency programs of study concerning ective management of lake systems.

ADMINISTRATION

In addition to the supervision and administration ies pertaining to SOD, functions related to member-p on various national and international committees uired approximately one-third of the Division Chief's e. Of major concern was his position as Canadian Chairman of the International Joint Commission per Lakes Reference Group. During 1974, the Upper kes Reference Group continued its three-year multi-lion dollar study of Lakes Superior and Huron to be npleted by the end of 1975, involving five states and tario, as well as the United States and Canadian ernments.

In late 1974, membership on a federal-provincial ke Winnipeg Water Quality Study Working Group led the preparation of a three-year study agreement for sideration by the governments.

MICROBIOLOGY LABORATORIES SECTION

The 1974 projects of the Microbiology Laboratories tion were oriented in three directions: development evaluation of microbiological, virological and mycol-al techniques used to assess water quality; involvement microbiologically oriented environmental research; and vision of support and guidance to in-house, provincial foreign projects.

Methodology studies included assessment of various dia and filtration practices to enumerate fungi in er; assessment of a variety of membrane filters and incubation temperatures on the recovery of health-oriented indicator bacteria from natural waters and effluents; development of a computer-assisted identification scheme for routine characterization of enteric indicator organisms; evaluation of ATP estimation procedures for ascertaining microbial biomass; assessment of fecal sterol preservation techniques and the relationship between bacterial populations and fecal sterol levels; evaluation and modification of freeze-drying techniques for bacterial preservation; and, in contracted studies, development and assessment of techniques for isolating and enumerating viruses from runoff from land-deposited sewage and sludge, from calcium hydroxide (high pH) treated sewage and sludge and from relatively uncontaminated river and lake water.

Environmental research studies were mainly centred on assimilation capacity of water bodies, microbial taxonomy and mycological studies. Assimilative capacity studies were undertaken in the field by means of a zonal grid sampling pattern to ascertain the impact and influence of effluent from a northern Ontario pulp mill on Lake Superior inshore and offshore waters. These field studies were supported in the laboratory by lake-simulating chemostat studies using the pulp mill effluent, lake water and indigenous microbial populations and various temperature regimes. Mycological studies were related to attempts to differentiate between eutrophic, mesotrophic and oligotrophic water by the distribution, density and taxonomy of fungal populations. Numerical taxonomic studies of bacteria isolated from Lakes Superior, Huron and Erie, and Georgian Bay are revealing the great differences between the freshwater isolates and the named or type-cultures that are used as representatives of existing taxa. The results indicate that carefully selected and often novel criteria (such as the use of a wide range of sole carbon sources at low levels) are necessary to produce significant clusters of organisms. Using such techniques, it appears possible to determine differences in bacterial population-composition corresponding with trophic levels.

Among the many projects supported by the Microbiology Laboratories Section's staff, those projects involving IJC commitments used approximately 80% of our support manpower. This support varied from advice, guidance and the loan of equipment to United States government-sponsored Great Lakes winter cruises to microbiological water quality studies of the St. Lawrence and St. Marys Rivers. During the year, 7 surveys of Lake Huron, North Channel and Georgian Bay (247 samples and 77 stations per survey) were completed by the Water Quality Assessment Unit, to collect base-line data and

provide information for the development of non-degradation water quality criteria.

The following contracts were monitored by the Microbiology Laboratories Section:

1) Studies on the Detection of Animal Viruses in Farm Effluent (Phase II) (Dr. J.B. Derbyshire, University of Guelph, Guelph, Ontario),
2) Development of Methods of Virus Analyses in Selected Areas of Lake Erie (Dr. E.L. Medzon, University of Western Ontario, London, Ontario),
3) Virological and Epizootiological Studies of Fish Neoplasms in Polluted and Non-Polluted Waters of Great Lakes (Dr. R.A. Sonstegard, University of Guelph), and
4) Examination of St. Lawrence River, Ottawa River, and Recreational Waters for the Presence of Human Pathogenic Viruses (Dr. J.C.N. Westwood and Dr. S.A. Sattar, University of Ottawa).

PHYSICAL SCIENCES LABORATORIES SECTION

Most of the effort of this Section was devoted to projects related to the IJC Upper Lakes Reference Study during 1974. Radioecological studies continued in the Radiochemistry Laboratory, where sediment cores from Lakes Superior and Huron were sliced into 0.5-centimetre sections for the determination of the vertical distribution of γ-ray emitting radionuclides. Radionuclides encountered other than those occurring naturally were ^{144}Ce, ^{137}Cs, ^{125}Sb and ^{155}Eu, which originated from nuclear weapon-testing in the atmosphere. They were found to be concentrated in the top 2 cm to 5 cm of the sediment cores and the concentrations of individual radionuclides varied markedly from core to core. These variations are probably due to differing absorptive capacities of sedimenting particulates in the lakes. Preliminary work on bioaccumulation of radionuclides through the aquatic food chain showed a concentration factor for ^{137}Cs of 6×10^3 from water to lake trout.

The distribution of asbestos fibres in Lake Superior was investigated by the Electron Microscope Laboratory to determine the impact on the lake of dumping taconite tailings containing cummingtonite asbestos off the Minnesota shore. Analyses of water samples taken during 1973 survey cruises were done at CCIW and by contract at the Ontario Research Foundation and McMaster University. The results for about 90 samples show that concentrations ranged mainly from 0.5 to 10 million fibres per litre with very few in the 10 to 100 million per litre range. The majority of samples contained chrysotil asbestos fibres only, with a mean length of 0.2 μm cummingtonite fibres were identified only in sample from the extreme western arm of the lake near th tailings dump.

Other radiochemistry projects included a determ nation of the direction of sediment motion by followir the movement of a radioactive glass sand with a submersibl detector. This project was carried out in co-operation wit the Geophysical Limnology and Engineering Sections o the east shore of Point Pelee on Lake Erie. A distinct north ward movement of the sediment was found by measurir the radioactivity for several days on a circular grid patter around the point of injection of the radioactive artifici sediment.

A method was developed to analyze for ^{210}P ($T\frac{1}{2}$ = 22 yr) in lake sediments, which is being applied t sections of a Lake Huron core. This radionuclide is daughter product of ^{222}Rn, which maintains a fair constant value in the atmosphere. The ^{210}Pb flux to th lakes is therefore also constant, providing a convenie tracer for the study of sedimentation processes.

The translocation of lead in algal cells grown sub-lethal concentrations of lead salts has been studied co-operation with Great Lakes Biolimnology Laborato using the transmission electron microscope. A techniqu for fixing the original location of the lead in the ce employing sodium rhodizonate was developed, which w then used to identify the process whereby lead absorbe by *Stigeoclonium tenue* is translocated to the two lar cell vacuoles.

The scanning electron microscope with its x-ra fluorescence analyzer was used to study the structure an composition of pyrite concretions, about 150 μm i diameter, in co-operation with the Geophysical Limnolog Section. This instrument was also used for taxonom studies of phytoplankton and bacteria.

DATA MANAGEMENT SECTION

The Data Management Section is responsible for t maintenance of the CCIW Data Archives, the IFYGL da bank and the provision of programming and techni services in support of CCIW projects. It is comprised three Units.

Computer Applications Unit

The Computer Applications Unit provides dir software support to CCIW projects. In addition,

rogram library has been expanded to contain approxi-iately 300 subroutines; improvements have been made to ie PDP-15 operating system for the production of 16 milli-ietre film to permit the program to co-exist with the lotting packages; an on-line data editing program using ie graphics display console on the PDP-15 has been eveloped; and EROS, a direct access retrieval program ritten under contract, has been implemented and a rogram for establishing communications and handling iessages to and from the ROBOT experimenter has been eveloped.

ata Archives Unit

The Data Archives Unit maintains, updates, and lits vessel survey data. Access to the USEPA STORET ita bank via a terminal located at CCIW permits the trieval of United States IFYGL limnological data gathered om Lake Ontario and its drainage basin. The University Toronto Great Lakes Institute data for 1960-1969 and ithythermograph data for all years have been processed id exist in both the STAR and EROS formats. The data inks in operation are STAR, EROS, STORET for vessel rvey data, STAR, for current meter and meteorological me series data and SAFRAS for geological and socio-onomic data.

ecial Projects Unit

The Special Projects Unit provides direct technical id clerical support to CCIW projects. Computer pro-ams were developed to produce a subfile of the STAR ta base and updating programs were written. A con-ntration of effort was expended in developing digitizing ograms for the Hewlett Packard 9100 calculator gitizer to alleviate hand-scaling of analog data rolls.

A statistician under contract provided consulting vices on data collection techniques, statistical data alysis, and mathematical model verification.

TECHNICAL OPERATIONS SECTION

As in the past, the majority of the field work for e Inland Waters Directorate at CCIW was carried out or pported by Technical Operations personnel on major search vessels and in field parties based onshore.

Tables 4, 5, 6 and 7 list the major vessels and the pes of cruises completed with Technical Operations pport.

rveillance Unit

During 1974, a Surveillance Committee, with mem-rs from the Lakes Research Division, the Great Lakes Biolimnology Laboratories and the Technical Operations Section, initiated a Great Lakes Surveillance program. Eighteen cruises were successfully conducted and reported by the Surveillance Unit of the Technical Operations Section.

Table 4. General Cruise Data

Vessel	Number of cruises	Miles steamed	Types of cruises
CSS LIMNOS	27	10,430.8	Current meter moorings; dynamic mooring analysis; sediment velocity studies; surveillance; engineering trials; sediment inventory; toxic materials survey; survey; sediment, seismic and coring
MV MARTIN KARLSEN	19	19,650.6	survey; surveillance; geolimnological studies; geochemical studies
CCGS PORTE DAUPHINE	14	9,063.8	surveillance; point source studies

Sensor Network Unit

The Sensor Network Unit, with an objective of installing, monitoring, and retrieving meteorological and specialized limnological equipment for CCIW, supported eight projects located at the Bay of Quinte, Main Duck Island, Lake Simcoe, Georgian Bay, Lake Huron, Morson Lake and Kamloops Lake. These systems consisted of meteorological buoys and towers, fixed temperature profiling systems, rain gauge systems along with special solar radiation measuring equipment. All of the data collected were edited by the Unit prior to submission to the project leader.

Diving Unit

The Diving Unit, which carries out all underwater activities in support of scientific programs, supported 24 projects in 1974, with over 400 underwater hours logged by CCIW and contract divers. These dives involved installation of scientific towers, installation of special current meters and wreck investigations and surveys.

SHORE-BASED SCIENTIFIC PROGRAMS

Major scientific programs based onshore supported by the Technical Operations Section are

Red Rock — a point source study in Nipigon Bay, Lake Superior, to study effluent containing toxic properties and nutrient energy (paper mill) on the aquatic community,

Table 5. Great Lakes Studies, CSS LIMNOS, 1974

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	31	1	2
FEB	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	1	2
MAR	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18 Depart CCIW 0905	19 Lake Ontario	20 Moorings	21 Lake Ontario	22 Moorings	23 Lake Ontario Moorings
	24 Arrive CCIW 1216	25 CCIW	26 Dep. CCIW L.Ont 1000 Mooring	27 Arr.CCIW L. Ont. 1700 Analysis	28 CCIW	29 CCIW	30 CCIW
	31 CCIW	1 CCIW	2 Dep.CCIW L. Ont. 0920 Side Scan &	3 Arr. CCIW L. Ont. 1500 Seismic Sur.	4 CCIW	5 CCIW	6 CCIW
APR	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
	14 CCIW	15 CCIW	16 Dep. CCIW L. Ont 1025 Sedimentation	17 Arr.CCIW L. Ont. 1210 Velocity	18 CCIW	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
	28 CCIW	29 CCIW	30 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW
MAY	5 CCIW	6 CCIW	7 CCIW	8 Depart CCIW 0555	9 Georgian Bay &	10 Lake Huron	11 Moorings
	12 Georgian Bay &	13 Lake	14 Huron	15 Moorings	16 Georgian Bay &	17 Lake Huron	18 Moorings
	19 Arrive 1300 Owen Sound	20 Owen Sound	21 Depart 1442 Owen Sound	22 Georgian Bay	23 Seismic And	24 Coring Survey	25 Arrive 0655 Owen Sound
	26 Owen Sound	27 Transit	28 Transit	29 CCIW	30 CCIW	31 CCIW	1 CCIW
JUNE	2 CCIW	3 Depart 1055 CCIW	4 Lake	5 Erie	6 Sediment	7 Inventory	8 Lake
	9 Erie	10 Sediment	11 Inventory	12 Arrive 0010 CCIW	13 CCIW	14 CCIW	15 CCIW
	16 CCIW	17 Depart 1004 Sediment	18 Arrive 1440 Velocity	19 CCIW	20 CCIW	21 CCIW	22 CCIW
	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW
JULY	30 CCIW	1 CCIW	2 Depart 0909 CCIW	3 Sediment	4 Coring	5 Lake	6 Huron
	7 Arrive 0707 Owen Sound	8 Owen Sound	9 Depart 0745 Owen Sound	10 Georgian Bay	11 Sediment Survey	12 Arrive 0113 Owen Sound	13 Owen Sound
	14 Owen Sound	15 Owen Sound	16 Depart 0450 Owen Sound	17 Huron and	18 Georgian Bay	19 Moorings	20 Huron and
	21 Georgian Bay	22 Moorings	23 Arrive 0945 Goderich	24 Goderich	25 Goderich	26 Goderich	27 Goderich
	28 Goderich	29 Depart 1600 Goderich	30 Huron	31 Georgian	1 Bay	2 Lake	3 Superior
AUG	4 Toxic	5 Materials	6 Arrive 0500 Sault Ste Marie	7 Transit	8 Transit	9 CCIW	10 CCIW
	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 Depart CCIW Sediment	16 Arrive CCIW Velocity	17 Open House Toronto
	18 Open House Toronto	19 Depart 0917 CCIW	20 Lake	21 Ontario	22 Surveillance	23 Arrive 1615 CCIW	24 ---------
	25 ---------	26 ---------	27 ---------	28 DOWN TIME	29 ---------	30 ---------	31 ---------
SEPT	1 ---------	2 ---------	3 ---------	4 DOWN TIME	5 ---------	6 ---------	7 ---------
	8 CCIW	9 Depart 1010 CCIW	10 Sediment Velocity Studies	11 Arrive 1545 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 Depart 0900 CCIW	17 Transit	18 Arr. Douglas Pt. 1100 Area	19 Moorings	20 Lake Huron	21 Transit
	22 Transit	23 Arrive 2010 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW
OCT	29 CCIW	30 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW
	13 CCIW	14 CCIW	15 Depart 0928 CCIW	16 Lake Ontario	17 Surveillance	18 Arrive 2120 CCIW	19 CCIW
	20 CCIW	21 Depart 1126 CCIW	22 Eng. Trials Lake Ontario	23 Arrive 0950 CCIW	24 CCIW	25 CCIW	26 CCIW
	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1 CCIW	2 CCIW
NOV	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW
	10 CCIW	11 Depart 1025 CCIW	12 Georgian Bay	13 Lake Huron	14 Moorings	15 Georgian Bay	16 Lake Huron
	17 Moorings	18 Georgian Bay	19 Lake Huron	20 Moorings	21 Georgian Bay	22 Lake Huron	23 Moorings
	24 Georgian Bay	25 Lake Huron	26 Moorings	27 Georgian Bay Lake Huron	28 Moorings	29 Arr. Goderich	30 Goderich
DEC	1 Goderich	2 Goderich	3 Goderich	4 Monitor	5 Georgian Bay &	6 Lake Huron	7 Monitor
	8 Georgian Bay	9 Lake Huron	10 Lake Erie	11 Lake Erie	12 Arr. CCIW	13 CCIW	14 CCIW
	15 CCIW	16 Dep. 1400 Lake Ontario	17 Moorings	18 Arr. 0300 CCIW	19 CCIW	20 CCIW	21
	22	23	24	25	26	27	28

Table 6. Great Lakes Studies, MV MARTIN KARLSEN, 1974

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4	5
	6	7	8	9	10	11	12
JAN	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	31	1	2
	3	4	5	6	7	8	9
FEB	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	1	2
	3	4	5	6	7	8	9
MAR	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31	1 Depart 1210 CCIW	2 Shakedown Cruise	3 Lake Ontario	4 Arrive 1017 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 Coring for Uni Wat	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
APR	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 Open House CCIW
	21 Depart 0905 CCIW	22 Transit	23 Arr. Sarnia 0200 Dep. Sarnia 1500	24 Lake Huron	25 Survey	26 Lake Huron	27 Survey
	28 Georgian Bay	29 Survey	30 Georgian Bay	1 Arrive 2240 Owen Sound	2 Depart 1030 Owen Sound	3 Arrive 0830 Sarnia	4 Sarnia
	5 Sarnia	6 Sarnia	7 Sarnia	8 Sarnia	9 Sarnia	10 Sarnia	11 Sarnia
MAY	12 Sarnia	13 Depart 0930 Sarnia	14 Lake Huron	15 Survey	16 Lake Huron	17 Survey	18 Georgian Bay
	19 Survey	20 Georgian Bay	21 Survey	22 Arrive 2200 Owen Sound	23 Owen Sound	24 Owen Sound	25 Owen Sound
	26 Owen Sound	27 Owen Sound	28 Depart 1535 Owen Sound	29 Transit	30 Lake Superior	31 Coring	1 Lake Superior
	2 Coring	3 Lake Superior	4 Coring	5 Lake Superior	6 Coring	7 Lake Superior	8 Arrive 1610 Thunder Bay
JUNE	9 Thunder Bay	10 Thunder Bay	11 Depart 1405 Thunder Bay	12 Lake Superior	13 Coring	14 Arrive 0900 Thunder Bay	15 Transit
	16 Arrive 0845 Owen Sound	17 Depart 2117 Owen Sound	18 Georgian Bay	19 Survey	20 Georgian Bay	21 Survey	22 Georgian Bay
	23 Survey	24 Lake Huron	25 Survey	26 Lake Huron	27 Survey	28 Arrive 0715 Sarnia	29 Sarnia
	30 Sarnia	1 Sarnia	2 Depart 1615 Sarnia	3 Lake Erie	4 Piston Coring	5 Lake Ontario	6 Piston Coring
JULY	7 Lake Ontario	8 Arrive 1540 CCIW	9 Depart 0917 CCIW	10 Lake Ontario	11 Coring	12 Lake Ontario	13 Coring
	14 Lake Ontario	15 Coring	16 Arrive 0830 CCIW	17 Depart 1700 CCIW	18 Transit	19 Arrive 1500 Sarnia	20 Sarnia
	21 Sarnia	22 Depart 1510 Sarnia	23 Lake Huron	24 Survey	25 Lake Huron	26 Survey	27 Lake Huron
	28 Lake Huron	29 Survey	30 Georgian Bay	31 Survey	1 Georgian Bay	2 Arr. 0405 Dep. 1000 Owen Sound	3 Transit
	4 Transit	5 Arrive 0200 CCIW	6 Depart 1210 CCIW	7 Lake Ontario	8 Survey	9 Arrive 0130 CCIW	10 CCIW
AUG	11 CCIW	12 Depart 1055 CCIW	13 Lake Ontario	14 Monitor	15 Lake Ontario	16 Arrive 1820 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 Depart 1730 CCIW	21 Lake Erie	22 Survey	23 Lake Erie	24 Survey
	25 Lake Erie	26 Arrive 0235 CCIW	27 Lake Huron	28 Survey	29 Lake Huron	30 Survey	31 Georgian Bay
	1 Survey	2 Georgian Bay	3 Survey	4 Georgian Bay	5 Arr. 0905 Dep. 1300 Owen Sound	6 Arrive 1500 Sarnia	7 Sarnia
SEPT	8 Sarnia	9 Sarnia	10 Sarnia	11 Sarnia	12 Transit	13 Transit	14 Transit
	15 Arrive 0200 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 CCIW	25 Depart 0900 CCIW	26 Transit	27 Arrive 0200 Sarnia	28 Sarnia
	29 Sarnia	30 Depart 1400 Sarnia	1 Lake Huron	2 Survey	3 Lake Huron	4 Survey	5 Lake Huron
	6 Georgian Bay	7 Survey	8 Georgian Bay	9 Survey	10 Georgian Bay	11 Arr. 0830 Dep. 1400 Owen Sound	12 Transit
OCT	13 Transit	14 Arrive 0230 CCIW	15 Dismantle Ship	16 Dismantle Snip	17 Dismantle Snip	18 Depart 1930 CCIW	19 Transit
	20 Transit	21	22	23	24	25	26
	27	28	29	30 OFF CHARTER	31	1	2
	3	4	5	6	7	8	9
NOV	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	1	2	3	4	5	6	7
DEC	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28

Table 7. Great Lakes Studies, HMCS PORTE DAUPHINE, 1974

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
FEB	27	28	29	30	31	1	2
	3	4	5	6	7	8	9
	1	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	1	2
MAR	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	2	22	23
	24	25	26	27	28	29	30
APR	31	1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16 Depart 1220 CCIW	17 Lake Ontario	18 Surveillance	19 Lake Ontario	20 Arrive 0220 CCIW
	21	22 Depart 0930 CCIW	23 Lake Erie	24 Surveillance	25 Lake Erie	26 Surveillance	27 Arrive 2319 CCIW
MAY	28	29 Depart 1235 CCIW	30 Lake Ontario	1 Surveillance	2 Lake Ontario	3 Arrive 0230 CCIW	4
	5	6	7	8	9	10	11
	12	13 Depart 0930 CCIW	14 Lake Ontario	15 Surveillance	16 Lake Ontario	17 Arrive 0030 CCIW	18
	19	20	21	22	23	24	25
	26	27	28	29	30	31	1
JUNE	2	3 Depart 1010 CCIW	4 Lake Cntario	5 Surveillance	6 Lake Ontario	7 Arrive 1735 CCIW	8
	9	10	11	12	13 NTA Hamil. Harbour	14	15
	16	17 Depart 0908 CCIW	18 Lake Cntario	19 Surveillance	20 Lake Ontario	21 Arrive 1600 CCIW	22
	23	24 Dep. 0840 Arr. 1930 CCIW	25 NTA Western L. Ont.	26	27	28	29
JULY	30	1	2 Depart 0900 CCIW	3 Lake Ontario	4 Surveillance	5 Arrive 1500 CCIW	6
	7	8	9 Depart 0900 CCIW	10 Transit	11 Transit	12 Transit	13 Arrive 0900 Red Rock
	14 Point	15 Source	16 And	17 Heat	18 Studies	19 Lake	20 Superior
	21 Point	22 Source	23 And	24 Heat	25 Studies	26 Lake	27 Superior
AUG	28 Point	29 Source	30 And	31 Heat	1 Studies	2 Lake	3 Superior
	4 Point	5 Source	6 And	7 Heat	8 Studies	9 Lake Superior	10 Depart 0600 Red Rock
	11 Transit	12 Transit	13 Transit	14 Arrive 0100 CCIW	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
SEPT	1	2	3 Depart 1400 CCIW	4 Lake Ontario	5 Surveillance	6 Arrive 2320 CCIW	7
	8	9	10	11	12	13	14
	15	16 Depart 0900 CCIW	17 Lake	18 Ontario	19 Surveillance	20 Arrive 0600 CCIW	21
	22	23	24	25	26	27	28
OCT	29	30 Depart 0935 CCIW	1 Lake Ontario	2 Surveillance	3 Lake Ontario	4 Surveillance	5 Arrive 0020 CCIW
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24 Depart 1230 CCIW	25 Dry Dock	26 Port Weller
NOV	27 Dry Dock	28 Port Weller	29 Dry Dock	30 Arrive 2050 CCIW	31	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25 Depart 1005 CCIW	26 Lake Ontario	27 Surveillance	28 Arrive 2125 CCIW	29	30
DEC	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16 Depart 0945 CCIW	17 Lake Ontario	18 Surveillance	19 Arrive 1540 CCIW	20	21
	22	23	24	25	26	27	28

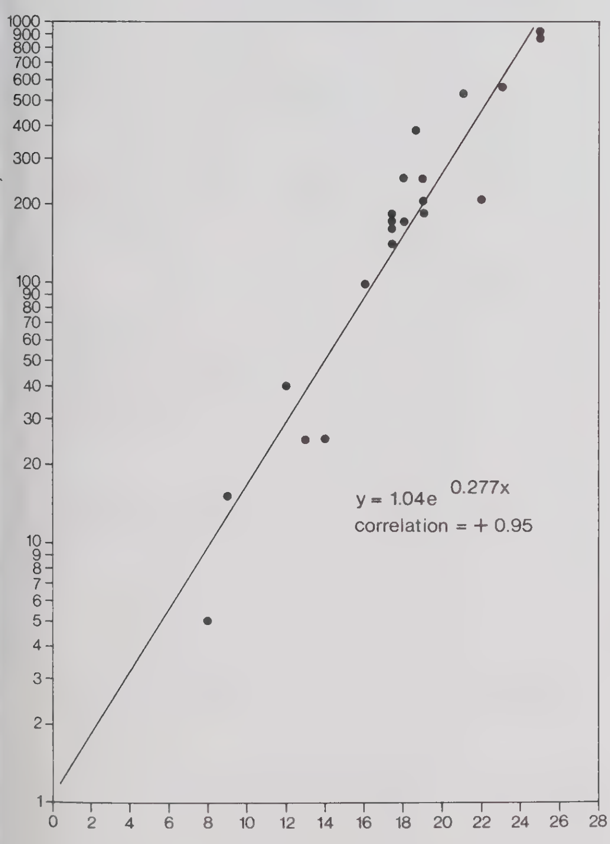
anticoke — a point source study on the effects of ectric generating plants, primarily waste heat discharge pon the Great Lakes ecosystem,

uinte — a study at the Bay of Quinte, Lake Ontario, on ie biogeochemical processes in lakes, and

amloops — a joint federal-provincial study on the physi- il, chemical and biological processes of a small lake— amloops Lake, B.C.

REMOTE SENSING SECTION

During 1974, the Remote Sensing Section con- icted programs centred on airborne photographic and frared reconnaissance, satellite data evaluation and transmission, lake optics, and sensor evaluation. Targets r intensive study included the Great Lakes and sur- unding basin, Lake Winnipeg, the Nanticoke Power enerating Station, the Red Rock Pulp Mill, the Point elee and Rondeau landforms, Cootes Paradise and Lake . Clair. Some of the pertinent results of these remote



gure 4. Correlation between ERTS-1 Band 6 (0.7-0.8μ) reflectance values and the concentration of surface chlorophyll *a*.

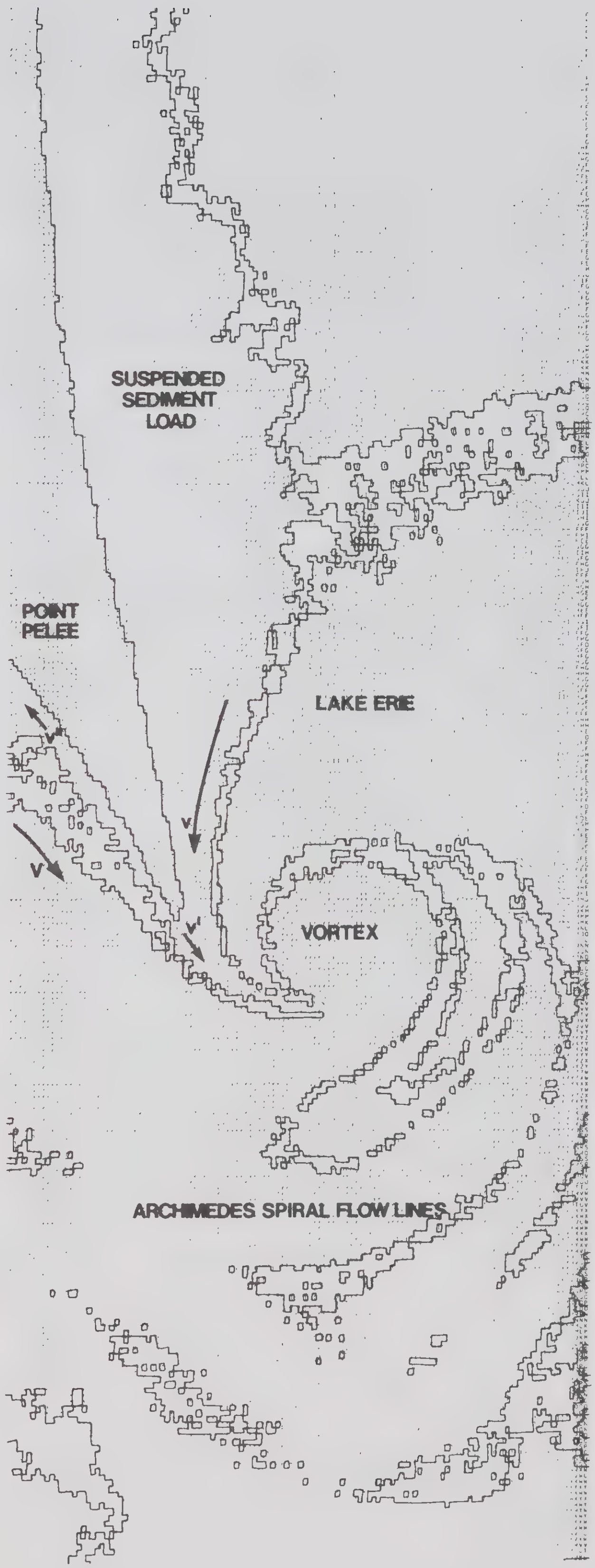


Figure 5. ERTS-1 observation of Archimedes spiral/vortex geophysical formation off Point Pelee in Lake Erie.

sensing studies include

1) direct correlations between the ERTS-1 Band 5 (0.6-0.7μ) digital data and surface turbidity; Band 6 (0.7-0.8μ) and Band 7 (0.8-1.1μ) digital data and surface chlorophyll *a* concentrations (Fig. 4),
2) the indication of a "back-flow model" theory for the temporal evolution of Point Pelee (Fig. 5),
3) the development of a "mirror-image" theory for the generation of the Point Pelee and Rondeau landforms based on bifurcated sediment transport along the northern shore of Lake Erie,
4) the delineation of distinct sediment transport zones in the Lake Huron-Lake St. Clair-Lake Erie system and the consistency between transport avenues determined from remote sensing techniques and shore-profiling networks,
5) the generation of maps delineating the temporal dependence of the optical transmission properties of several of the Great Lakes,
6) progress in correlating water quality data with intrinsic remotely sensed parameters (such as volume reflectance and colour indices),
7) the ability to distinguish between organic and inorganic loading using the Kullenberg scattering meter (Fig. 6),
8) the Nanticoke thermal plume was localized in space and displayed a maximum temperature difference of 7°C from the ambient lake waters,
9) the meteorologic dependence of the wastewater plume emanating from Red Rock, and
10) the Data Communications Package (DCP) network study, initiated as an interaction vehicle in the ERTS-1 satellite, was extended to applications to the GOES satellite and the proposed all-Canadian satellite. Progress has been made in establishing an agreement between DOE and the National Oceanographic and Atmospheric Administration (NOAA) in this regard.

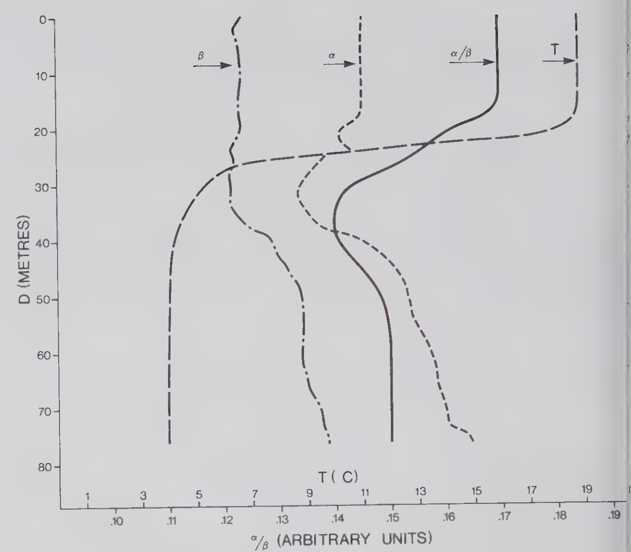


Figure 6. Typical scattering, transmission, temperature and α depth profiles in Georgian Bay.

During 1974, Dr. K.P.B. Thomson left his positi as Acting Section Head to join the Applications Divisi of the Canada Centre for Remote Sensing in Ottawa.

The following contracts were monitored by t Remote Sensing Section during 1974:

1) Airborne Spectroscopic Measurements for the La Huron and Georgian Bay 1974 Survey (CRESS, Yo University),
2) Construction of an Integrated Scattering Meter (Ins tute of Physical Oceanography, Copenhagen, Denmar
3) L'étude limnologique avec les données digitales d'ER (CENTREAU, Université Laval),
4) An Evaluation and Interpretation of ERTS Image Relating to Lakes Research and Management Accordance with Submission for Research, Big Qu Lake IHD Representation Basis (J. Whiting, Saskatc ewan Research Council), and
5) Study and Evaluation of Remote Spectroscopic Measu ments in Water Quality Surveillance (W. R. McN & Associates, Toronto).

SCIENTIFIC SUPPORT DIVISION

ENGINEERING SERVICES SECTION

The Engineering Services Section provides engineering support services to all divisions at CCIW, including those not in IWD.

These services emphasize innovative design and development engineering initiated both in the Section and as requested by the scientific users. Also featured are various equipment modification and improvement programs, p preventive and corrective maintenance performed on t substantial and increasing CCIW environmental inst ment inventory. This support is centred on a professio design-engineering and maintenance-engineering capabil in the technological fields related to inland waters inst mentation and equipment. Services also provided incl technical drafting, illustrating, equipment-testing, inst ment calibration, machine-shop prototype manufact

nd technical supervision of procurements from Canadian ndustry.

Shown in Table 8 is a list of significant activities performed in the Engineering Services Section during 1974. Some highlights of the projects that were completed with major impact on other areas are outlined. Many projects, still underway or in the initiation stages, are not mentioned. No attempt has been made to group projects according to the two Units within the Engineering Services Section because many, if not most, were realized through a co-operative effort.

Table 8. Summary of Engineering Systems, Projects and Services for 1974

coustic Bed-Load Transport Monitor (for river system studies)
loored FTP Systems (increased to 9 systems; winter and summer configurations)
pecial Low Cross Section Towers
IDIR System (reconfiguration for fish-monitoring)
tandard Submersible Battery Power Supply Design (primary and secondary)
ı Situ Interstitial Water Sampler
rogrammed Fluorescent Dimming Systems (further expansion of the 1972-1973 programs)
CIW EBT Systems (ES-007/Engineering Rationalization Program), quantity: 7
utomated Water Sampling
quatic Biota Photo-stimulation System
nproved Instrument Calibration Facilities
atellite-Telemetry Monitoring Systems (Lake Winnipeg, GOES Satellite), quantity: 2
ccurate Calibration Services (temperature, pressure, conductivity *et al*)
CIW Timelapse Photo-logger Systems (underwater and above water)
CIW Acoustic Release Units (improvement program), increased from 7 to 24
ı Situ Fluorometer (study-improvement program), dye diffusion
pecialized Coring Devices (Point Pelee; light weight)
nvironmental Data Storage Modules (survey of magtape units)
loored Metbuoy Systems, with Sensors (inventory 22 systems)
omprehensive Extensive Maintenance Operations
loored Current-Measuring Buoys, quantity: 90 self-recording units
coustically Triggered Bottom Camera System (application at Point Pelee)
'ind-Wave Flume Data Acquisition System (continued consulting)
rystal Temperature-Sensor Module
lumes for Hydraulic Studies in Cold Room Trials
CIW Transmissometer Technology
uto-sequencer and DO-Profiling Winch System (in-house lake-column simulators)
lectromagnetic Current Sensors (Technical Evaluation Program, Point Pelee)
CIW Active Towed-Body System Engineering
lectro-optical Measurements Facility
ish Population Density Monitor System (acoustic echo analysis)
ecirculating Flume
ortable Towed Temperature Profiling System (shallow water FRB system)
olid-State Relative Humidity Sensor Module
onductivity Sensor Technology
Multichannel (multiparameter) Environmental Monitoring System Development
Diode-Matrix Sequencer Unit
Extensive Illustration Services
Standard CCIW Digital Integrator Module
Signal Conditioning System for Boundary Layer Data Analysis
In Situ Temperature Recorders
Towed Temperature-Profiling (ADDS) System (testing, calibration, maintenance)
Towed Radioactivity Bottom-Tracer Detection System (less navigation equipment)
CCIW Turbidity Measurement Techniques
CCIW Divers Sonic Communication and Location Techniques
Auto-sequenced Profiling Winch System with Pumping
Fish-Tracking Biotelemetry System
Sidescan Sonar System Upgrade
Acoustic Pebble Tracking Technology

SYSTEMS, PROJECTS AND SERVICES—1974

Aquatic Biota Photo-stimulator (Project BL011)

Late in 1973, design engineering commenced to develop a functionally flexible photo-radiation system for use by Great Lakes Biolimnology Laboratory (GLBL) biologists in studying the photo-responses of aquatic invertebrates and other biotic specimens. Early in 1974, this system was defined, specified, procured, assembled, tested, and installed in the environmental toxicology laboratory. It can transmit into biotic test chambers incident light radiation of a wide intensity range (50db); varying radiation incidence (vertical to horizontal); and fully controlled spectral distribution (monochromatic to polychromatic).

Bed-Load Transport Acoustic Monitor (Project HY011)

An important measurement problem in river system studies is the movement or transport of riverbed material. In this connection, it has been hypothesized that the underwater noise patterns produced by such bed-load movement may be recognizable, and characteristic. To aid these studies, a special low-drag wide-bandwidth acoustic recording system was engineered during 1974. Figure 7 shows this system, which recorded considerable acoustic field data in spring runoff conditions. These river noise recordings are being analyzed by CCIW Hydraulics staff, and an unpublished report has been prepared on the system.

Sediment Dynamics, Point Pelee (Project LR071)

This project concerned the determination of the causes of erosion of Point Pelee. An Alpine Vibracorer was leased to obtain sand cores in the vicinity and Engineering Services helped in its deployment. Experience gained has since been applied to the modification of the CCIW Jackhammer corer. Also required for the project were four

electromagnetic current meters mounted close to the lake bottom. Special support structures were designed and built for these meters and were installed by using a water-jetting technique. To enable the Radiochemistry group to measure sediment transport using radioactive tracers, prototype equipment was designed, built and field-tested for depositing and tracking the radioactive material using a scintillation detection unit. Particular care was taken with respect to safety in handling the tracer material (Fig. 8). Several sand traps were also designed and manufactured, and a diver-operated vacuum cleaner was constructed for collecting the sand samples.

Acoustically Triggered Underwater Photo-system (Project LR070)

Frequently CCIW geolimnological studies of lake sediments require photo-images of the bottom regions where core samples are taken. These necessitate a method of repeatedly taking bottom photographs at a known, short distance from the bottom, without making contact; a short-range acoustic depth sounder was used, with an adjustable digital threshold and bottom-lock facility so that

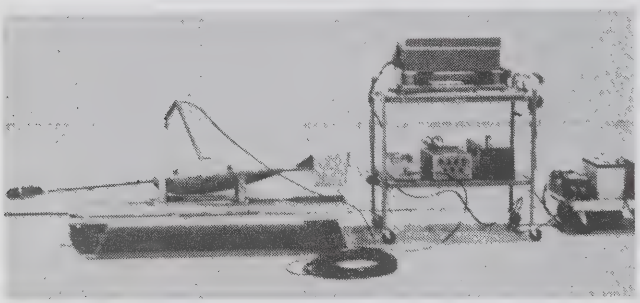


Figure 7. Bed-load transport acoustic monitoring system.

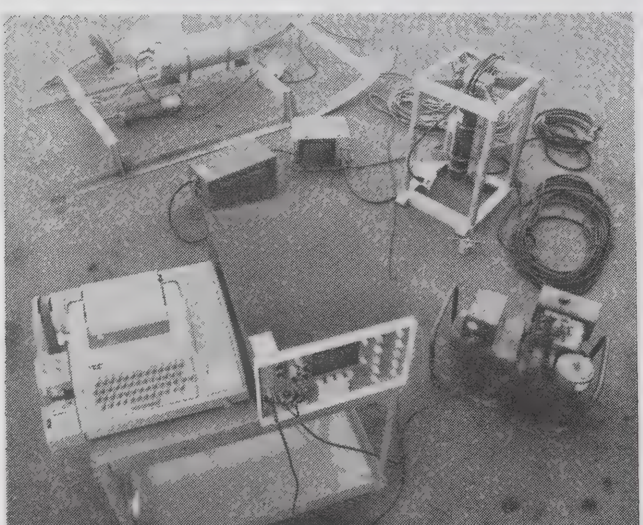


Figure 8. Prototype neutron-activated sediment-tracking system.

bottom exposures were taken on the descent at a known preset height above the sediments. The entire photo system was completed this year (Fig. 9) and used intensively during the Point Pelee studies.

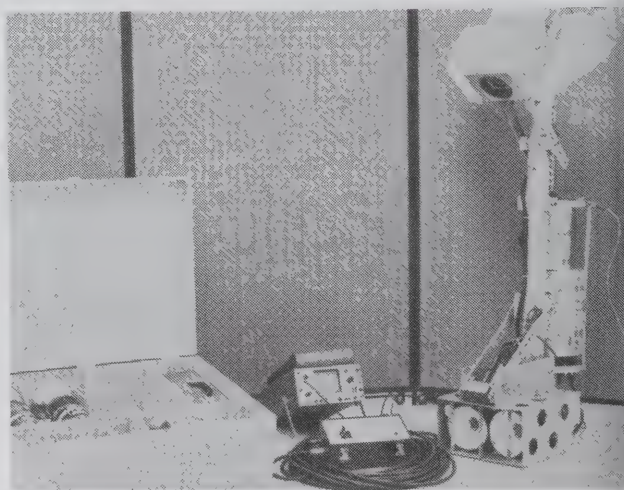


Figure 9. Acoustically triggered underwater photo-system.

Portable Towed Thermistor Array System (Project BL01

To establish clearly the thermal regime in areas bei studied by GLBL, a portable 8-channel temperature-recor ing system to be towed by small boats was required. Th system (Fig. 10), largely created from standard CC modules, features a light-weight V-fin towbody, high-spe resistive sensors, a locally made electromechanical cab assembly, and a multistylus analog display. Very go results were obtained.

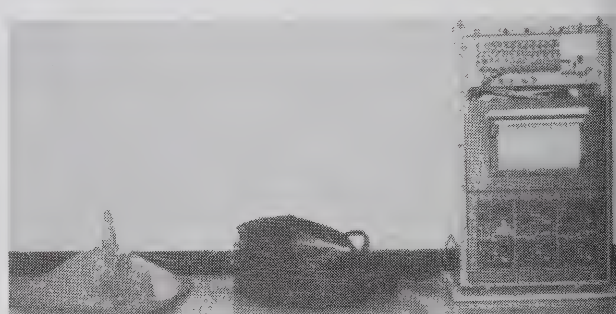


Figure 10. Portable towed thermistor array system for GL studies.

Wind-Generated Waves (Project LR070)

Engineering participation in this project was obtain some fundamental design criteria for lake towe i.e., dynamic loads under storm conditions. This v necessary because of the failure of two towers in La Ontario during 1973. Two types of towers were test the first is a cylindrical column with a base that be floated to the site and sunk in position and the secon an aluminum lattice-type (Millard) structure. Both tow

ere installed off Burlington Beach and instrumented / Orenda ($12,000 contract) with strain gauges and celerometers. A computer dynamic analysis program ing the data obtained from the tests is now being epared in conjunction with Multiple Access ($7000 ntract). Figure 11 shows the towers installed.

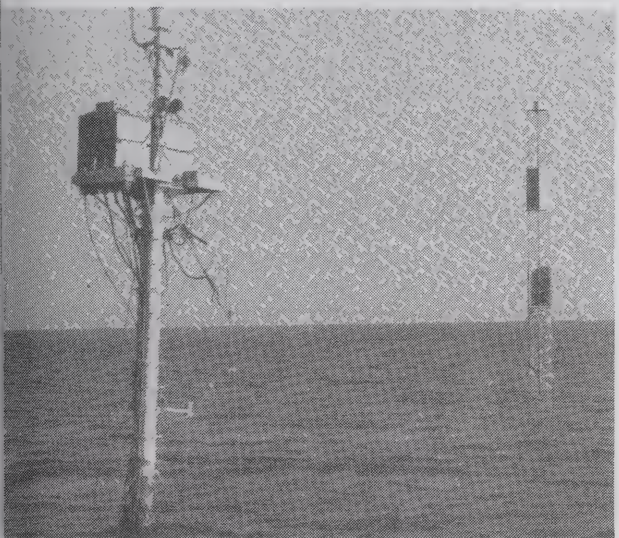


Figure 11. Towers under environmental test.

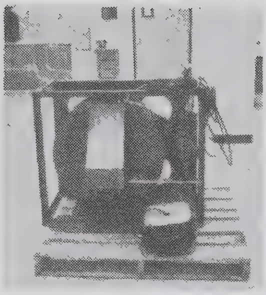
A contract was awarded to Whitman-Benn Associates design a portable independent platform, which includes, addition to the actual tower structure, a telemetry stem. This contract, valued at $21,000, will enable gineering Services to provide a standard tower for use in e Great Lakes and similar bodies of water in support of entific study programs.

rtable Towed *In Situ* Fluorometer System (Project R011A)

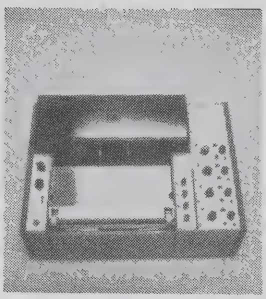
The prediction of the movement of liquid pollutants Canadian lakes and rivers is helped by experiments volving the controlled release of an artificial tracer uid such as rhodamine dye. The subsequent distribution d concentration of this dye tracer are readily measured detecting its fluorescence when optically stimulated. simple system, comprising an improved underwater uorometer, towing winch, and multichannel chart dis- ays, was completed and tested satisfactorily during e year (Fig. 12).

wed Underwater Platform (Project ES-4)

The use of ships and staff, and the compatability of ta obtained from different parts of a lake would be creased if instruments could be towed continuously at gh speed or if samples of water could be collected ntinuously across a lake. In a survey of existing towed dies, the Batfish, developed by the Bedford Institute of



Towing winch



Multi-sensor display

Tow-body with sensors

Figure 12. Portable towed *in situ* fluorometer system.

Oceanography, Halifax, was selected as the most suitable towed body. A study on how to increase the payload of the actual body resulted in an additional pod being attached to the belly of the Batfish, and this configuration was lake-tested with excellent results. The design of a pumping system for the Batfish has been completed; the components of this system will be available for testing in 1975. Initial consideration has been given to a dynamic study of the towed platform so that the effect of changes to the system can be quickly determined. Also, a bottom-following device is being designed for the Batfish in order that it can be towed within several metres from the lake bottom (Fig. 13).

Figure 13. Active towed body, Batfish.

Sonic Fishtags and Biotelemetry (Project EL017 *et al*)

In 1974, for the first time at CCIW, a limited engineering effort was applied to biotelemetry, particularly to the evaluation of specifications and the use of sonic fishtags. This work was in support of both the GLBL and Wheatley research station programs, mainly in connection with the Nanticoke studies. Such fishtags, when used along

with shipboard tracking receivers, provide valuable data on fish-life behaviour in different near-shore zones.

Electro-optical Measurements Laboratory (Project SSD014)

One of the Scientific Support Division's projects was the establishment of an electro-optical measurements laboratory, with appropriate staff capability. This provides a hardware-oriented engineering support to the considerable inventory of CCIW optical limnology equipment and a design capability and industrial overview with respect to electro-optical instrumentation. In late 1974, this project was completed. Figure 14 shows typical CCIW photodetector instruments undergoing performance tests in the laboratory.

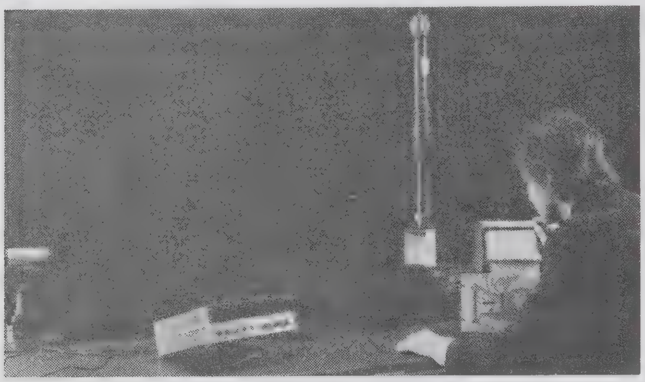


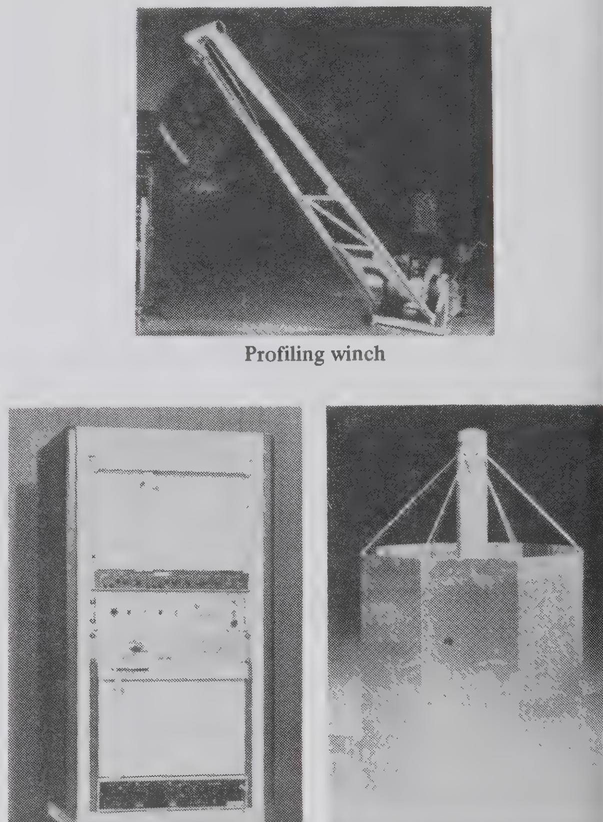
Figure 14. Tests on submersible photometric instruments in Electro-optical Measurements Laboratory.

Automated Water Sampling (Project WQ 16)

Since the need for a 48-hour cycle, variable interval water-sampling system could not be met by existing commercial units, it was designed and built at CCIW. The system enables water to be pumped from a lake or river to the shore where it is collected in 24 sterile bottles. Contamination of each discrete water sample is avoided by having the supply of sample water pumped continuously, so that no residual water from a previous sample can remain in the supply line. The prototype unit is presently operating on the Niagara River where it will be evaluated for winter sampling.

Kamloops Lake Regional Study Instrumentation (Project LR067)

In 1974, a major regional multidisciplined environmental study was conducted at Kamloops Lake, B.C., and its adjacent Thompson and Fraser River sections. In support of this program, CCIW Engineering Services specified, prepared, tested and dispatched the following major shipment of environmental measuring instrumentation: 4 fixed temperature profiling (FTP) systems; 2 shore-based metpack systems; 4 submersible digital recorders; and 1 turbidity-temperature profiling system, as well as spares. Figure 15 shows the latter systen complete with sensor cage, profiling winch, remote contr units and system displays.



Profiling winch

System displays

Sensor cage

Figure 15. Temperature-turbidity-depth profiling system.

Improved Instrument Calibration Facilities (Project SSD003)

Some limited work was done in 1974 with respect improved CCIW calibration facilities for electronic instr ments used for inland waters research. Existing in-hou facilities, such as for depth, pressure, temperature, we augmented to include *in situ* conductivity and boundar layer relative humidity (Fig. 16). In many instances, course, such work is contracted to Canadian industry (e. underwater acoustic calibrations).

In Situ Interstitial Water Sampler (Project LR072)

In the past at CCIW, interstitial water has be obtained by taking a sediment core sample and squeezi it to remove the water. Since it is known that bo temperature and time can affect the composition of t interstitial water in the core, a new sampler was designed extract the interstitial water *in situ* directly from t sediment. The principle was originally evolved by t Woods Hole Oceanographic Institute and has been adapt to our application. The sampler is shown in Figure 17.

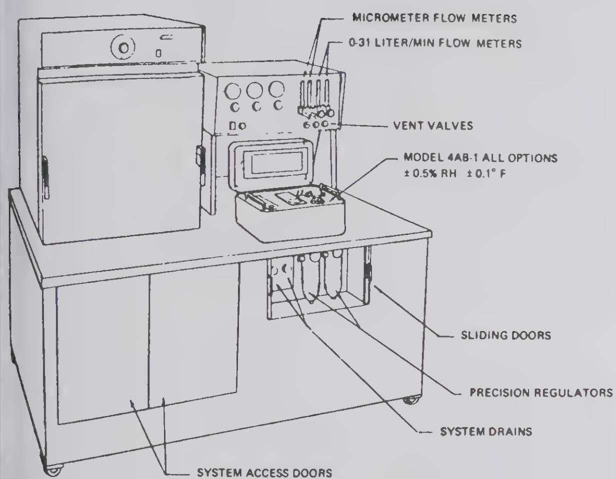


Figure 16. Improved instrument calibration facilities.

coustic Fish-Censusing Systems (Project BL017)

For GLBL biologists, considerable engineering effort vas applied to prototyping an improved acoustic echo nalysis system that could obtain higher resolution data on nland waters fish stocks, their distribution and variations. This prototype system was completely designed and de-eloped during 1974 (Fig. 18). It features a directive coustic transducer with over-the-side mounting rig; ultra-onic transceiver; fibre-optics intensity display; hardcopy ligital printout; digital magtape storage; and a digital-logic cho analysis unit with full operator controls. This proto-ype system was extensively used on the CCIW ship AQUA n Lakes Superior and Erie, against both natural fish opulations and standard geometric targets for *in situ* ystem calibration.

While this development was underway, a similar rototype system was required by OMNR biologists at Vheatley research station. This second system was also rototyped using system engineering services from Cana-lian industry, installed on Wheatley's vessel KEENOSAY nd regularly used this field season.

lydraulics Division Ice-Wave Flume (Project 4-IW-HY009)

This flume consists of a wave-generating apparatus nounted in a trough to produce waves of desired amplitude nd frequency. The flume has a 4-metre long working ection with temperature-controlled windows for observa-ion purposes. Connected to the flume is an insulated old-water reservoir with full pumping facilities. Design of he flume was started during 1973, but the unit has now een built and tested in co-operation with Hydraulics ersonnel (Fig. 19).

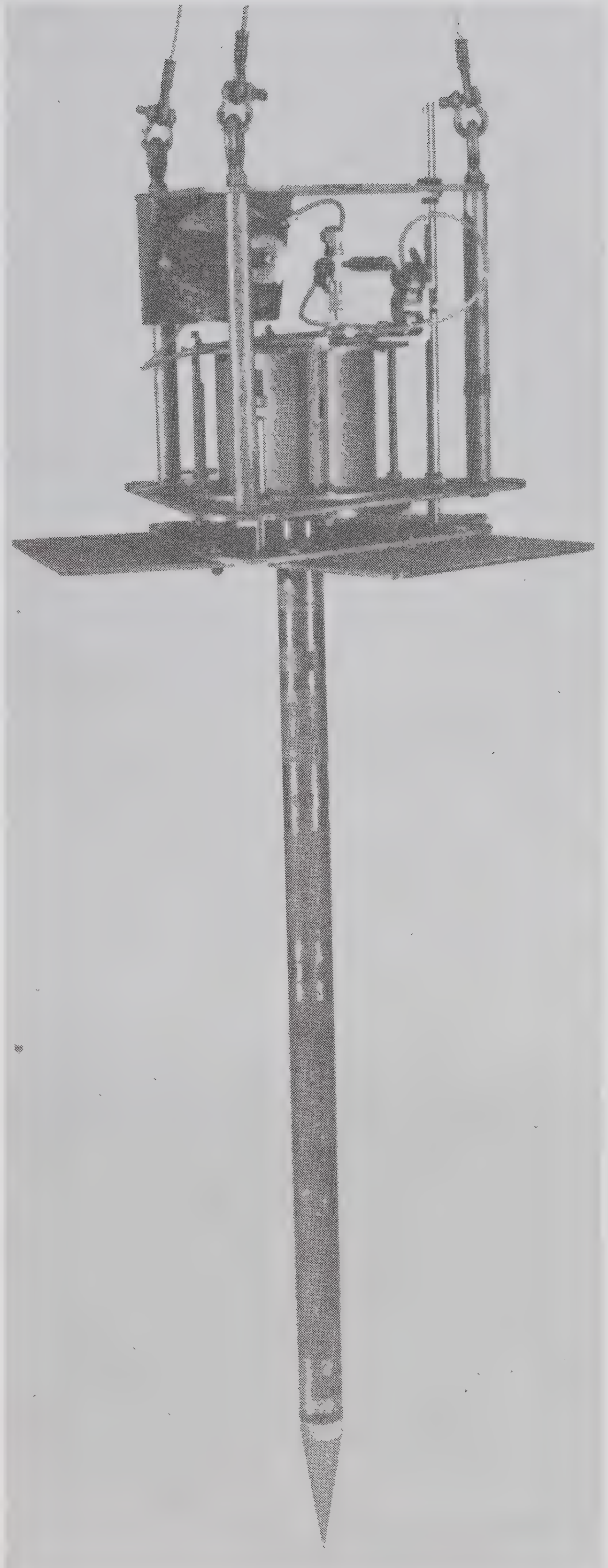


Figure 17. Interstitial water sampler.

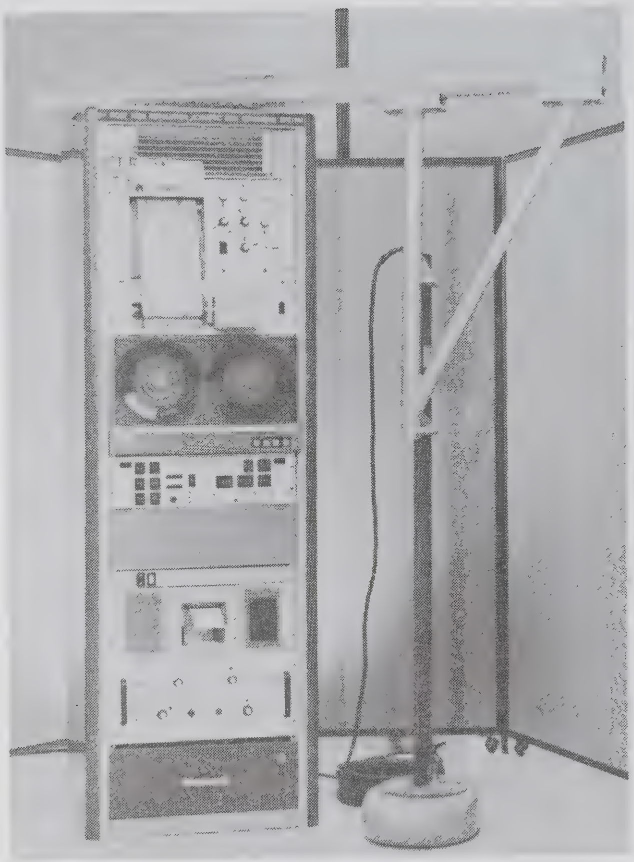


Figure 18. Prototype acoustic fish-censusing system.

Figure 19. Flume for cold conditions studies.

CCIW Submersible Turbidimeters (Project LR067)

In 1974, chiefly in support of the Kamloops program, some engineering effort was applied to the area of *in situ* turbidity monitoring, which before had been largely based on Secchi disc methods. In association with Canadian industry, a low-power wide-range turbidity sensor for general use in Canadian inland waters was developed (Fig. 20). Both manually and remotely scaled versions of this instrument have been produced, and many satisfactory turbidity profiles have been recorded.

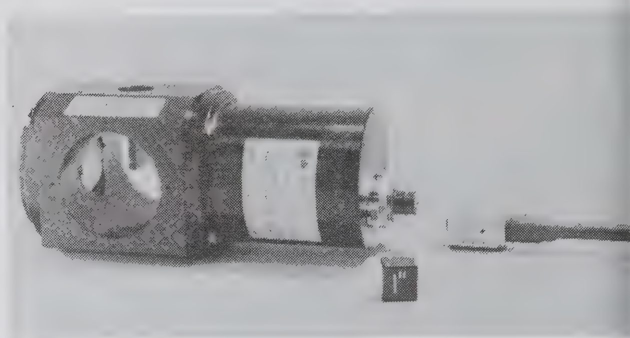


Figure 20. Submersible turbidity sensor developed in co-operatior with Canadian industry.

Hitachi Mass Spectrometer Improvement Program

As part of the normal instrumentation improvement and modification program, engineering effort was expendec to reduce system self-noise and residual drift (corre spondingly increasing the analysis detection limits) and to improve the overall performance of the Hitachi/Perkir Elmer RM6-U mass spectrometer system (Fig. 21) in the Analytical Methods Research Section. This work includec programmable EHV power supply for the ion-accelerator; stable 5-kV voltage for the electron-multiplier, solid state femtoamp electrometer preamplifier; improvec

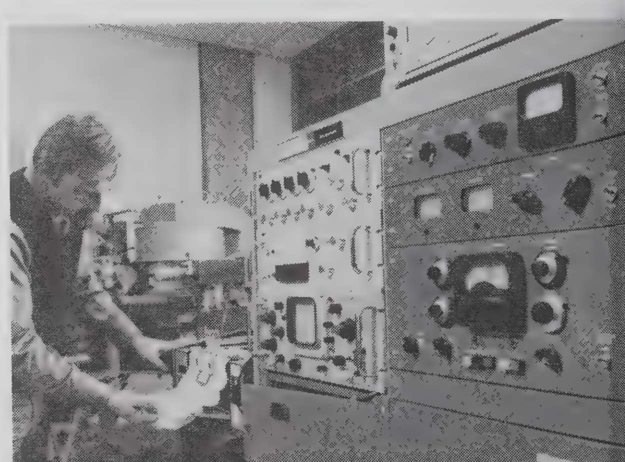


Figure 21. Incorporation of improved system modules to CCI Hitachi mass spectrometer installation.

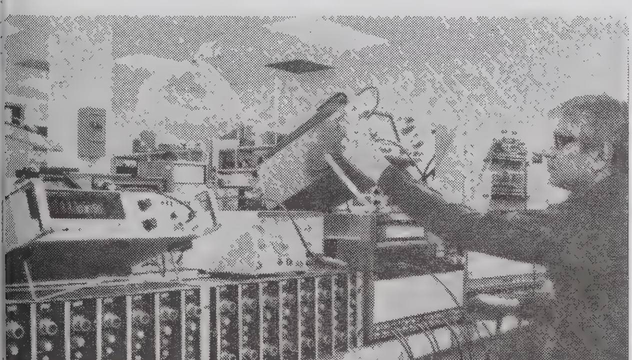
Gaussian filtering of the spectral signal; and low-noise buffering to the computer input. Preliminary results show a noticeable reduction in system noise and drift.

Recirculating Flume (Project 4-IW-HY010)

The flume has been designed for the Hydraulics Division, which will be studying the flow behaviour of water under winter conditions. It consists of an 11-metre ong trough working section with insulation and temperaure-controlled walls; the viewing windows are doublelazed and heated. A headbox and tailbox are installed at he ends of the working section, and water is recirculated y a pumping system. Above the working section is a wind unnel for studying the effects of wind on heat exchange nd ice behaviour. The flume is pivoted at one end so hat it can be tilted by electrically driven jacks up to a naximum slope of 3%. A contract for the manufacture and nstallation of the flume has been awarded.

Air-Water Interaction (Micromet) Systems (Project LR033)

During 1974, the engineering effort was applied to his system with respect to the 1972 (IFYGL) model and he forthcoming (1975) configuration. For the IFYGL, the ystem was necessary for the optimal analysis of the urbulence Subsystem field data, which are composed of nany 4-track and 7-track field tapes. Considerable effort vas directed to the area of tape-speed auto-compensation; 6-channel demultiplexers; phase/amp response of Bessel ilters; and time-decode comparator to provide a flexible nstallation whereby up to 24 channels of wide-band urbulence data could be digitized prior to PDP-15 comuter analysis (Fig. 22).



igure 22. Electronic instrumentation for pre-processing IFYGL Micromet turbulence field data.

ransponding Acoustic Pebbles (Project LR021)

During 1974, a new technique was added to those used t CCIW for measuring the storm-induced movement of kebed and riverbed material. This technique, essentially a acer method, involves the use of acoustically transponding pebbles" of natural size, shape, density, and surface roughness, intermixed with natural pebbles or shingle (Fig. 23). Field-monitoring involves a CCIW launch equipped with regular sidescan sonar. The sidescan triggers a response from the acoustic pebble, which is displayed as an intense echo-mark on the sidescan display. Various navigation references are possible, but the reference used in 1974 was two fixed similar "benchmark" transponders driven into the bottom.

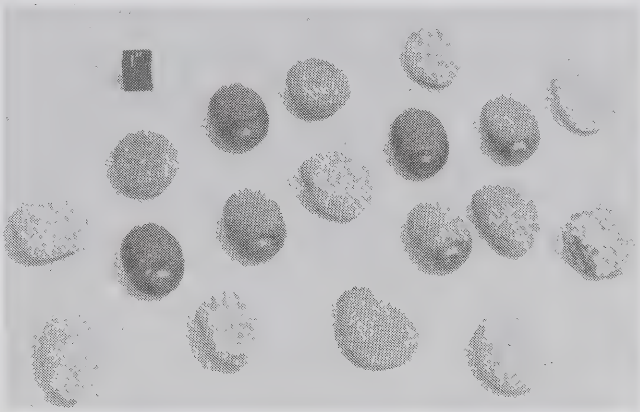


Figure 23. Acoustic transponding and natural pebbles.

Drafting and Illustration

The Drafting and Illustration group provides drafting services to all divisions in support of research programs at CCIW.

These services include: mechanical drawings for the manufacture and development of scientific instruments and related equipment; electronic schematic and block diagrams for instrumentation systems; approximately 2000 charts, graphs, cartographic maps and illustrations required for scientific and engineering publications, and photographic slides for seminars and conference commitments.

Maintenance, Repair and Calibration of CCIW Instrument Inventory (Project SSD003)

The Maintenance and Calibration group provides the CCIW scientific and technical community with instrumentation services encompassing incoming inspection, preventive maintenance, equipment modification and improvement, fault diagnosis, corrective maintenance, performance-testing and instrument calibration.

Equipment functional areas are
—electrochemical and analytical instrumentation,
—underwater data acquisition systems,
—electronic test equipment and instruments,
—basic standards and calibration, and
—contract technical supervision.

Servicing of some 1500 items of common-user equipment, worth approximately $3 million, continued during

the year. About 250 internal Work Orders covering non-standard requirements were processed in support of various scientific groups at CCIW. As well as to the Glaciology Division, DOE, some limited support was provided to outside agencies, such as Ontario Hydro and the Ontario Water Resources Commission, which were working on common programs with CCIW scientists in areas in which CCIW has the only high-accuracy calibration facility.

In accordance with federal policy, a considerable amount (approximately $200,000) of maintenance work was contracted out to Canadian industry, e.g., a CGE contract for $149,000. This is near the optimum for contract maintenance, since a contract should cover a reasonable quantity of relatively standard commercial equipment to be economical. These contracts covered such instrumentation items as current meters, digital data-loggers, Teletypes, boundary-layer sensors, temperature probes, chart recorders, radiation sensors and digital test units (Fig. 24).

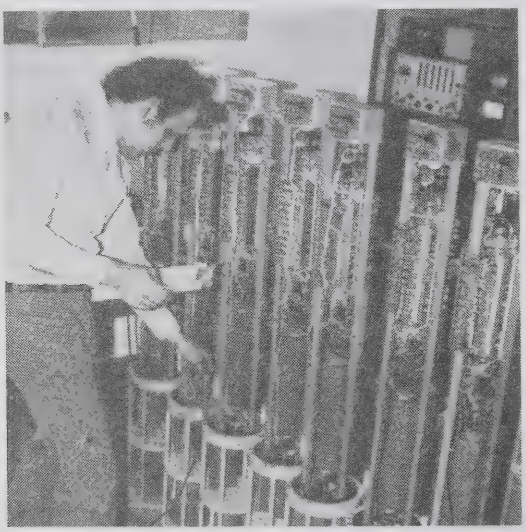


Figure 24. Inland waters self-recording instruments under maintenance of Canadian industry.

An important continuing function is the checking and modification of the large amount of prototype equipment and of the systems developed and serviced during the year that are required to meet Ontario Hydro standards, and thus ensure the safety of CCIW personnel.

In mechanical engineering, a large proportion of the work in the workshops is devoted to the maintenance and repair of instruments and related equipment. Typical equipment includes corers, water-sampling devices, numerous types of pumps, electric motors and drives, towers and special winches. Preventive maintenance is always applied wherever possible to reduce down-time while in the field. Modifications are also made to equipment for a wide variety of reasons, such as better reliability, accuracy ar safety, as determined necessary from field and laborato experience. Other services offered are pressure-testing fac ities for underwater equipment and a common-user wor shop with light machinery, tools, and assistance available CCIW staff.

Standard Submersible Power Supplies

In conjunction with Canadian industry, a standa battery module was developed for general application in wide range of underwater measuring and recording syster and limnological instruments. This design achieves consi erable flexibility in use, both electrically and mechar cally, since various supply voltages and energy capaciti can be readily generated, as different equipment or missio may require. Shown in Figure 25 are both the basic batte module itself and its packaged configuration for su mersion in Canadian inland waters. Both the batte module and the underwater package are readily available Canada.

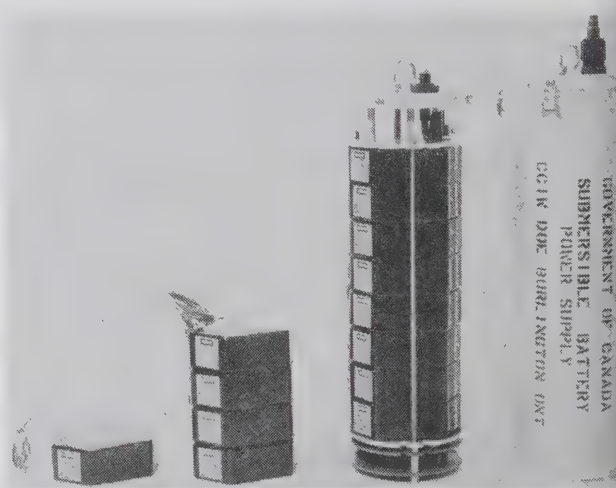


Figure 25. Configuration of the CCIW standard submersible pow supply.

Auto-controlled Daylight Simulators (Project BL010)

To an increasing extent, CCIW laboratory expe ments involving plant-life and animal-life processes requ some degree of controlled daylight radiation to simula natural conditions better. For this purpose, a portab modular, controlled radiation system had previously be designed and developed in conjunction with Canadi industry. During the year, the fourth CCIW version of th system was assembled, tested, and installed in one of t environmental toxicology laboratories. Figure 26 shows t various system modules prior to installation.

Fixed Temperature Profiling (FTP) Systems

In 1974, these moored systems evolved from being item under development to an accepted standard CC

easurement tool. Simultaneously, expanded scientific stu-es necessitated additional purchases of data-loggers, sen-rs, cable assemblies, and test units to increase the oper-ng inventory from 4 (in 1973) to 9. These 21-channel gital recording thermistor-chain systems were deployed Lake Ontario, Lake Huron and Kamloops Lake. A satis-ctory data recovery factor (about 90%) has been achieved.

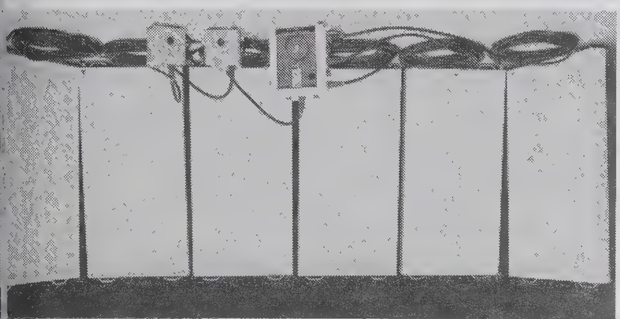


Figure 26. Auto-controlled daylight simulators.

IW Acoustically Triggered Underwater Release Units

As in other instrumental areas, once problem areas re eliminated and reliable operation attained, appli-ions increased noticeably for acoustic release units, ecially for use under the ice in winter. From a 1973 mber of 6 units, 1974 operating inventory is now 17, d all 17 were deployed in winter moorings in various es (Fig. 27).

Figure 27. Acoustically triggered underwater release units.

IW Temperature-Depth Profiling (EBT) Systems

Engineering work to upgrade and standardize a erse inventory of temperature-depth sensing equipment s finally completed in 1974. Equipment performance has n technically satisfactory and operationally more re-ble. Logistically, especially with respect to interchange-lity, the situation has improved greatly. As determined much use, CCIW now has an inventory of 4 mainly automatic "major-ship" EBT systems designed for year-round use and 3 hand-operated portable EBT systems for use from CCIW launches (Fig. 28). Strong features of the systems are modular interchangeability for easy mainte-nance and Canadian manufactured content.

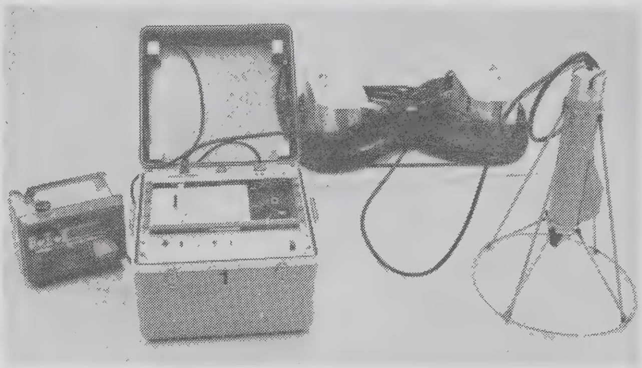


Figure 28. Portable EBT system for use from CCIW launches.

CCIW Submersible Data Acquisition Systems (Project SSD006)

For many years CCIW has used a wide variety of data-acquisition systems to measure inland waters para-meters. Most of these systems were limited to one measure-ment operation only, and none effectively exhibited the functional flexibility, accurate digitizing, ultralow power and reliability in performance and operating economy that current solid-state electronic technology can provide. Against this background, work commenced in 1974 to use the spe-cialist engineering services of Canadian industry, together with in-house applications experience and proven equip-ment methods, to prototype a special submersible main-frame digitizer and rackmount mainframe digitizer for evaluation in certain limnological experiments.

Standard Inland Waters Electronic Packaging

In 1973, a standard electronics packaging format for submersible inland waters use was in the final design stage.

Figure 29. CCIW submersible electronics package for inland waters use.

Since then the design has proven very satisfactory. More than a dozen electronics packages been implemented with no leakages. In 1974, an accidental event produced an interesting "torture test" whereby a submersible digital recorder package (Fig. 29) was washed free on the Thompson River, B.C., during the spring flood. The recorder was carried down the Thompson River, across Lytton Bar, down the Fraser canyon, including the unnavigable "Hell's Gate" narrows, for a distance of 200 miles almost to tidewater at Chilliwack. Despite rocks, logs, abutments and other hazards, and after having had all sensors torn off and connectors severely battered, the electronics assembly was dry and undamaged — still digitizing to its original value of ±1 bit accuracy.

Air-Water Timelapse Photo-logger System

Effort was applied during the year to defining, selecting and requisitioning a functionally flexible 16-millimetre timelapse photo-logger system that is able to record extensive series of photo-images either underwater or above water, in the laboratory or in lakes. Many applications exist at CCIW for such a photo-logger. The system is modular and features sets of air-compensated and water-compensated lenses; incremental operation with wide-range timing controls (milliseconds to hours), strobe and/or photocell-inhibit; and digital recording in the image plane of data from associated environmental sensors.

Environmental Sensor Engineering

During 1974, engineering design work conducted in the area of improved environmental sensors for inland waters application was even more limited than in 1973, and this was a small fraction of what should be done. Examples of environmental sensors that received some limited engineering attention, however, are electromagnetic current sensors, turbidity sensors, and fluorescence sensors. There are many other parametric measurement areas in which CCIW methods can be improved in 1975 by using electronic sensing instrumentation of more contemporary and economic performance.

Moored Current Meter Buoys and Metbuoys

CCIW has on inventory about 20 air-water interface metbuoy systems and about 30 moored current-measuring systems, each with 3 meters. During 1974, about 250 moorings of these systems were made in Lakes Huron, Superior, Ontario, Simcoe, and Kamloops Lake; the data recovery factor was about 90%. All refurbishment, preparation, testing, and calibration of this equipment is contracted to Canadian industry, with generally satisfactory results.

Automatic Dissolved Oxygen Profilers (Project BL016)

In connection with various CCIW nutrient-dynamic and phosphate-control experiments, there are requirement for repetitively profiling the DO levels in restricted exper mental enclosures. For this purpose special automatic D profiling systems were developed, featuring DO and tem perature sensors; digital integration facilities; automati vertical and slewing controls by diode-matrix sequence 6-station operation; and 4-parameter displays. Two system now exist: one system for the Bay of Quinte limnocorral and the other for the GLBL lake-column simulators, wit step-and-slew profiling every 15 minutes, 24 hours a da for an operation of many months.

LIBRARY SERVICES

A Vucom terminal was acquired by the librar courtesy of the Social Sciences Division for informatio retrieval purposes. The three systems regularly interrogate are WATDOC, CAN/OLE and RESORS. WATDOC provid access to an increasing variety of specialized data base including Health Effects of Environmental Pollutant CAN/OLE, with its specific search strategy, is primari used for retrieval from *Chemical Abstracts* and *Biologic Abstracts,* whereas RESORS is comprehensive for remot sensing. The number of users of computer literatur searching is growing, and since the equipment is now mo reliable and more data bases are available, this segment c library services will be used more in future years. Librar staff demonstrated the terminal to visitors from nearb universities and other interested agencies, as well as t CCIW staff.

The volume of library work increased, as the diversit of CCIW research grew; interlibrary loans for staff membe showed an increase to 3750. Volume 6 of *Collected R prints* was published.

TECHNICAL SERVICES SECTION

The Technical Services Section is responsible for th operation and maintenance of all the present real proper at CCIW, as well as developing the means to satis requirements for additional space, equipment, facilities ar services throughout CCIW.

Two items of significance during 1974 were th transfer of the Department of Public Works (DPW) heati and power plant staff to CCIW, under the supervision the head of this Section, and the transfer of all contractu responsibility for maintenance services and constructi from Headquarters to CCIW. These services and constru

tion contracts were previously managed locally by DPW and DSS for the Facilities Planning Branch in Ottawa. Several building renovations and modifications were carried out throughout the year with minimum disruption to ongoing programs.

A major program on safety and fire emergency procedures, involving all components located at CCIW, was initiated. An internal sign-posting project, approved by Information Canada, was incorporated into the building complex.

COMPUTER SERVICES SECTION

The Computer Services Section has the responsibility for operating and providing software support for the major computer systems at CCIW, as well as providing off-line services such as key punching and consultation in the technical aspects of electronic data processing.

The Control Data (CDC) 3170 computer system, which was upgraded in late 1973, has been operated under the MASTER multiprogramming system throughout 1974 with no significant difficulties. The system has been operating from 8 to 12 hours per day during this year, and as the computer work load has not increased considerably, no serious strain has been placed on the computing facilities. During 1974, a total of 49,331 jobs were run, using 1369 hours of central processor (CPU) time. Detailed usage statistics are given in Table 9.

Table 9. Summary of Computer Services Usage–1974

Type of usage	Amount	
CDC 3170 computer		
Number of jobs	49,331	jobs
Central processor usage	1,369	CPU hr
I/0 channel usage	287	hr
Lines printed	47 million	lines
Cards punched	1.45 million	cards
Magnetic tapes mounted	27,886	tapes mounted
Private disk packs mounted	2,640	packs mounted
Total value of usage	$664,846	
Average value/job	$13.48	
Average CPU time/job	1.66	min
Average lines printed/job	952	lines
PDP-15 and plotter		
Number of plotting jobs	2,153	jobs
Total plotter usage	658	hr
Other PDP-15 usage	871	hr
Data preparation services		
Number of cards keypunched	316,517	cards
Number of cards interpreted	1,078,465	cards
Total value of Computer Services usage		$714,761

In addition to the CDC 3170 computer, the section has a DEC PDP-8 computer used to reformat instrumentation tapes to "computer-compatible" form and a large DEC PDP-15 used for special applications, such as plotting, interactive graphics, analog-to-digital conversion, and the production of time-sequence data displays on movie film.

INSTRUMENT RESEARCH AND DEVELOPMENT UNIT

The program of the Instrument Research and Development Unit was focused on the development of sensors and automatic sensing systems for monitoring water quality parameters *in situ*. Working from the conclusions of earlier requirement surveys, the decision was made to undertake developments which had potential for monitoring parameters, such as algal biomass, organics, nutrients and toxic substances, leaving the development of the typical five-parameter monitors (temperature, pH, conductivity, dissolved oxygen and turbidity) to several commercial concerns already active in this field.

The major effort centred on designing and constructing a submersible system of apparatus and sensor modules called the Robot Experimenter. It took the form of an *in situ* experimental station in which candidate techniques for measuring these water quality parameters could be tried and evaluated. The submersible apparatus modules produced included a family of precision pumps for handling water samples and reagents and standard solutions, a novel 8-port commutator valve, and a standardized flowcell block for electrodes and other small sensing devices. A high-speed cable telemetry subsystem was designed to provide remote control of these modules and to send back observations made by the sensing elements. The heart of the system is a minicomputer, which directs the detailed activities of the apparatus modules and performs simple data acquisition and analysis. The system will have facility for a user, located at central site, to program the experimental station and to observe its activity and data files by a conventional dial telephone data link. A novel software package was created especially for this minicomputer so that routines for directing the activity at the station could be written in a simple code and executed with real time controls.

Phase I of this experimental station project will be completed in the summer of 1975. It is expected to have the basic ability to measure the parameters of temperature, pH, conductivity, dissolved oxygen, chloride ion, total CO_2, total alkalinity, total heavy metals and a simple BOD index. These parameters will be taken as the results of simplified

analytical experiments conducted within a particular configuration of the apparatus modules and performed on a continuous schedule by a set of programmed routines in the minicomputer.

Another project of Instrument Research and Development Unit is the development of a new dissolved oxygen sensor to be used in applications where dissolved oxygen must be monitored for long periods of time, in the order of six months, without manual attention. Work has centred on a new measurement cell resembling the conventional polarographic probe, but which operates on a significantly different principle called semi-integral electro-analysis. This device employs an oxygen permeable membrane as a selectivity filter only. Consequently the cell does not suffer calibration drift associated with changes in the membrane permeability coefficient, which currently limits the measuring life of conventional probes. Since it is operated in a pulsed mode and has no need of an external agitating device, it requires very little power and allows long life for its active reagents.

Development of the operating principle theory, design criteria and the production of three prototype probes resulted from a research contract with Dr. K.B. Oldham, Trent University. Following favourable evaluation of these prototypes, a production version will be attempted and manufactured commercially.

SOCIAL SCIENCES DIVISION

This Division provides viewpoints and techniques of the social sciences for the development and operation of balanced water management policies and programs. This year the transfer of the Division from CCIW to the Inland Waters Directorate, Ontario Region, was discussed and scheduled for 1975. The Division Chief has been named Chairman of the newly established Socio-Economic Programs Sub-committee for the Ontario Region Environmental Management Service.

In 1974, the Division continued to diversify the skills in its field of activity. Data bases were expanded further, and much effort was applied to the development of economic and social models for water management. Staff members continued to participate in joint projects with other divisions, departments and government agencies.

Throughout 1974, various projects were undertaken.

ENVIRONMENTAL ATTITUDES AND BEHAVIOUR

The major project in this area was an evaluation study of the International Joint Commission's public hearing process. Eighteen public hearings conducted by the IJC in 1973 were examined. One of the main tools of evaluation was an analysis of a questionnaire sent to all of the participants at the hearings on the IJC list of attendees. The report was presented to the Commission at its annual October meeting by the Research Advisory Board, and as a result, some changes were instituted in the public hearing procedures. The Division was then asked to undertake a follow-up study of the hearings in the autumn of 1974, to examine the effect of these changes.

A study was completed by Resources Management Consultants to examine the public relations function of CCIW. Managerial personnel and members of the Public Relations Unit were interviewed. In addition, a sample survey was undertaken to determine the level of awareness of CCIW on the part of the general public and water managers in key areas across Canada.

ENVIRONMENTAL CONTAMINANTS

Progress continued with the composition of papers describing the production, use and distribution of environmental contaminants in Canada. Two reports, one concerning the sales of pest control products and the other describing the production and use of cadmium, were published in the new "Environmental Contaminants Inventory Series." Similar documents on lead, phthalates, selenium, beryllium and antimony are to be added to the Series in 1975. These reports form the basis for other natural science and social science studies in progress. Work has begun on the development of methodologies to determine the social costs that accrue as a result of the use of environmental contaminants in the Canadian economy.

ECONOMIC IMPACT STUDIES

The economic impact of waste-heat discharges was studied under contract by Canadian Resourcecon. Estimates were made of the direct costs involved in installing wet cooling towers on facilities discharging waste heat into the lakes. These direct costs were translated into electricity price increases, and the propagation of these price increases through the economy was examined.

As part of a contracted study on Regional Economic Activities by Informetrica, a general methodology is being developed to provide a quantitative assessment of the economic impact of the various policy instruments open to water managers.

LEGISLATIVE AND INSTITUTIONAL STUDIES

Four major projects were completed in this program area. A study of the legislative framework and administrative processes by which municipalities acquire sewage treatment facilities was concluded. Laws, agencies, regulations and administrative procedures were examined, as they operate both at the federal and provincial levels to provide sewers and sewage treatment plants for municipalities.

The second project involved the examination of legal, political and administrative aspects of public participation in resource management. A report outlining the legislative basis for public participation in Canadian water management was produced by C. G. Morley, Professor of Law, University of Manitoba. A more general presentation based on this paper was made at the 17th Annual Conference on Great Lakes Research in Hamilton.

Thirdly, a working paper on institutional arrangements for the management of the Great Lakes was completed in conjunction with staff of the Ontario Ministry of the Environment for Working Group A of the IJC Upper Lakes Reference Group. The paper outlined the legislation and the agencies involved in various aspects of water management at all levels of government. Staff also assisted the United States Great Lakes Basin Commission in compiling a directory of institutions involved in water management in the Great Lakes.

Finally, to develop management policies which will cover water quality problems of the future, a study has been contracted out to L. J. D'Amore and Associates to provide a largely intuitive, but adaptable, model of social, technological, legislative and institutional trends to the year 2020. The model is based on data from the Canadian portion of the Great Lakes basin and is designed to define the "unexpected results of reasonable trends," that is, the synergistic effects of developments in these areas. The results will be incorporated into waste-loading and land-use forecasting and policy simulation models being developed for the International Joint Commission's Reference Groups on Upper Lakes Water Quality and Pollution from Land-Use Activities.

DYNAMIC MODELLING

The Social Sciences Division is involved in developing a long-term dynamic model to assess the effects of population and economic activity on the waste loadings into Lakes Superior and Huron. The economic forecasts being used are obtained from the CANDIDE model of the Canadian economy, and the social, legislative, technological and institutional modules are being constructed from data obtained from the synergistics model. This policy simulation model, developed under contract, will contribute to both our level of knowledge and to government policy-making, as society makes its decision about the amount of waste materials to be added to our waterways.

SOCIO-ECONOMIC BASE-LINE STUDIES

Owing to the Social Sciences Division's responsibility for Canadian co-chairmanship of Working Group A of the Upper Lakes Reference Group, a considerable amount of socio-economic data describing the Upper Great Lakes basin were collected. Studies were developed using these data to describe the population distribution, market characteristics, recreational facilities and use, economic conditions and detailed economic activity, for selected river basins in the upper Great Lakes basin.

With respect to the Reference Group on Pollution from Land-Use Activities, the collection of background information on various land uses (mining, agriculture, manufacturing activities, etc.) is continuing. This information will be used to study the nature and location of land-use patterns in the entire Great Lakes basin. In addition, a report on specialized land uses was completed by Crysler and Lathem (consultants). When all the information is complete, a set of forecasts will be developed for all sectors and activities of land use that affect the drainage of pollutants into the Great Lakes.

As part of the federal-provincial Great Lakes Shore Damage Survey, an inventory of ownership, value and use of all properties along the Canadian shoreline of the Great Lakes is being compiled. Data have been collected and analyzed for Lakes Ontario, Erie and part of Lake Huron. A Coastal Zone Atlas, incorporating this information on data strips, is being produced.

A detailed set of long-term economic activity estimates for the Great Lakes basin has been developed by Informetrica. The first publication, the "A-Series," is based on a set of assumptions, compatible with a continued trend in the development of the service industry. On the basis of a range of alternative assumptions, work continues on a "B-Series" set of estimates.

CCIW LECTURE SERIES

The Division maintains responsibility for the CCIW lecture series. The objective is to provide scientific staff at CCIW, as well as at neighbouring universities and research institutes, and other government agencies in southern Ontario, with a series of lectures focussing on unifying principles in multidisciplinary environmental research. Speakers in 1974 included Dr. David Suzuki, Dr. Tuzo Wilson, Mr. David Estrin, Dr. O. M. Solandt and Dr. Donald Chant.

ANALYTICAL METHODS RESEARCH SECTION

The past Analytical Methods Research Section (AMRS) responsibilities with respect to a number of national and international programs have continued and in many areas broadened. Extensive consultations were held with the staff of the federal regional laboratories in Vancouver, Calgary, Burlington and Moncton, in which their current and near-future analytical research requirements were identified. A three-day training course on the application of the high-pressure liquid chromatography was given by the AMRS staff in December. The course was attended by eight chemists from the regional laboratories and a chemist from the EPS Laboratory in Ottawa.

During the year, a biochemist was engaged to conduct research on 1) biodegradation of surfactants, 2) estimation of biomass in water, and 3) determination of heavy metals in cells.

SCOPE

Presently, AMRS comprises six 2-man teams specializing in 1) gas chromatography/mass spectrometry (GC–MS), 2) high-pressure liquid chromatography, 3) selective-ion electrodes, 4) polarography and molecular fluorescence, 5) UV/visible/IR/and atomic absorption spectrometry, and 6) biochemical methodology.

All analytical research at CCIW is carried out in response to the needs expressed by the following: 1) any federal regional laboratory, 2) any research component of the CCIW, and 3) any international organization with which Canada is actively collaborating.

PUBLICATIONS

During 1974, AMRS staff published 14 papers; 13 additional papers were "in press" by the end of the year. Detailed references are listed in alphabetical order in Appendix B. A partial summary by discipline or instrumental techniques applied is provided here.

Chromatography-Mass Spectrometry

A variety of organochlorinated pesticides, their photo-products, dithiocarbamates and 1,4-oxathiins have been characterized, and analytical methodology for a number of industrial pollutants has been developed by means of gas chromatography, high-pressure liquid chromatography, thin-layer chromatography, tandem GC–MS, NMR and IR.

Determination of N,N-Dialkyl Dithiocarbamates in Wast water by Thin-Layer Chromatography
(F.I. Onuska)

The procedure involves extraction of the organ pesticide in chloroform in the presence of a copp dichloride solution. The dried extract is first dissolved ether, which is removed under vacuum, re-extracted wi chloroform and applied to a precoated silica gel pla containing a fluorescent indicator.

Gas-Liquid Chromatography and Mass Fragmentography c S-n-Propyl N-Monoalkyl Dithiocarbamates
(F.I. Onuska and W.R. Boos)

Dithiocarbamates are esterified with 1-iodopropar to form S-n-propyl MADTC followed by gas chromat graphic separation, mass spectrometric identification ar mass fragmentographic quantitation. Individual compoun were characterized by means of Kováts retention indice These values increase with increasing chain length of tl hydrocarbon linked to nitrogen. Higher Kováts retentic indices were obtained when the column was packed wi polypropylene glycol adipate (Reoplex 400), than when was packed with Apiezon L or silicone oil DC-200. MADT showed two simple fragmentations with molecular ion mo abundant in N-methyl-DTC.

Photoalteration of cis- and trans-Chlordane by U Light: Isolation and Characterization of the Photoalter Metabolites
(F.I. Onuska and M.E. Comba)

Ultraviolet irradiation of *cis*-chlordane and *tran* chlordane yielded three photolysis products: one hal caged analog of *cis*-chlordane in high yield and tw minor photoproducts of trans-chlordane, one of them beir a half-caged isomer. The photoproducts were isolated t TLC and characterized by IR, NMR and MS.

Isolation and Characterization of Some Methanonaphth lene Photoproducts
(F.I. Onuska and M.E. Comba)

Photo-decomposition products of aldrin, dieldrin ar endrin were characterized by means of GC–MS, NMR ar IR. One isomeric product of aldrin and four endrin analo were encountered. The mass spectra of eight photoproduc were presented with direct inlet spectra of endrin aldehyc and endrin.

A Highly Sensitive Technique for the Liquid Chromat graphic Analysis of Phenols and Other Environment Pollutants
(A.W. Wolkoff and R.H. Larose)

Phenols are extracted into n-butyl acetate from a 00-millilitre sample, acidified to pH 2 and back-extracted ı 1.6N NaOH. The aqueous phase neutralized to pH 7 is djusted to 10 ml, thus affecting a fifty-fold concentration. sample portion is injected into the L.C. column with an cetonitrile water mixture as the mobile phase. The eparated phenols in the effluent react each with a Ce (IV) olution in a fully automated system to give Ce (III), which as a fluorescence proportionate to the concentration of ıdividual phenols.

eparation and Detection of Low Concentrations of Poly-ıionates by High Speed Anion Exchange Liquid hromatography
A.W. Wolkoff and R.H. Larose)

A method is described for the separation and mea-ırement of thiosulphate and polythionates by high-speed nion exchange chromatography. The sulphur-oxygen nions are oxidized by cerium (IV) and the fluorescence of ne resulting cerium (III) is proportionate to the concentra-on of the polythionates. The detection limit is of the rder of 1 ppm to 4 ppm.

pectrophotometry: UV, Visible, Molecular Fluorescence, R, Atomic Absorption

Analytical methodology has been developed in the nalysis of organic pollutants (phenols, formaldehyde), norganic pollutants (chlorides, arsenic, antimony, sele-um) and detergents (phosphate, citric acid). Some of the ethods developed are briefly summarized here.

he Determination of Formaldehyde and Related Com-ounds in Water and Industrial Effluents
.K. Afghan, A.V. Kulkarni, R. Leung and J.F. Ryan)

The method is based on the reaction of formaldehyde ith 2,4-pentanedione and ammonia to form a fluorescent mpound. The fluorometric method is more specific than e colorimetric procedure based on the reaction with romotropic acid. The analysis rate is 10 to 20 samples per ur depending on concentration, and the detection limit is pproximately 10 μg/l.

utomated Fluorometric Method for Determination of tric Acid in Sewage and Sewage Effluents
.K. Afghan, R. Leung and J.F. Ryan)

Citric acid is first converted to citraconic anhydride accordance with the Furth-Herman reaction, and then e latter is condensed with pyridine to form a fluorescent mpound. The rate of analysis is 10 samples per hour. ılvic acid, a common interference in the spectro-hotometric and gas chromatographic methods, was found ot to have an effect in the molecular fluorescence method. No other significant interferences were found.

A Modified Procedure for the Determination of Phosphorus in Detergents
(P.D. Goulden and M.C. Holton)

The ASTM Method (D820-72) for phosphorus in detergents has been modified to make it applicable to phosphate levels below 5% P_2O_5 by elimination of carbonate and some refinements in titration.

A New Automated Colorimetric Method for the Determination of Chloride Using Chromotropic Acid
(B.K. Afghan, A.V. Kulkarni and J.F. Ryan)

The new colorimetric method for chlorides is based on the catalytic action of chlorides to convert nitrate to nitrite and the colour reaction with chromotropic acid. The method is automated, allowing the analysis of 40 samples per hour in the range of 0.25-100 mg/l.

Electro-analytical Methodology

Publications under this heading describe activities mainly in the area of application of selective-ion electrodes to multi-element analysis and the development of new selective-ion electrodes. There has been also some advancement in voltammetric applications.

Simultaneous Determination of Sodium, Potassium and Ammonium Ions by Automated Direct Potentiometry
(I. Sekerka and J.F. Lechner)

A method is described for the simultaneous analysis of sodium, potassium and ammonium ions by automated direct potentiometry in natural and wastewaters, allowing the analysis of 20 samples per hour with the detection limits of 0.1 ppm for sodium and ammonia and 1 ppm for potassium. The relative error is ±2%.

Automated Simultaneous Determination of Water Hardness, Specific Conductance and pH
(I. Sekerka and J.F. Lechner)

The analysis can be performed at the rate of 20 samples per hour.

Determination of Nanogram Quantities of Carbonyl Compounds Using Twin-Cell Potential Sweep Voltammetry
(B.K. Afghan, A.V. Kulkarni and J.F. Ryan)

Twin-cell potential sweep voltammetry allows both the determination of the carbonyl compounds and the differentiation among the individual compounds in natural waters and industrial effluents. Detection limits in sub-ppb ranges are achieved. Standard deviation is of the order of 2.5-10%, depending on the nature of the carbonyl compound.

OTHER ACTIVITIES

The Analytical Methods Research Section participated in a number of international programs. Experimental studies were carried out on biodegradation of surfactants, in co-operation with the countries belonging to the Organization for Economic Co-operation and Development (OECD); state-of-the-art surveys were conducted on behalf of the International Joint Commission on the analy tical methodology of the Great Lakes; and a co-operativ program with Mexico was initiated on the detection o carcinogenic polynuclear aromatic hydrocarbons.

Dr. S. Barabas, who had visited the Soviet Unio in December 1973, reported on water research carrie out there.

WATER AND WASTEWATER TREATMENT RESEARCH SECTION

The Water and Wastewater Treatment Research Section conducts investigations of the treatment of water. The work of the Section is focused on methods of removing or destroying substances in water that may be harmful to humans or to industry. A brief description of the scientific projects conducted by the Section follows.

Reduction of Surface Inhibition on Reverse Osmosis Membranes
(H.K. Johnston)

This study was conducted with the assistance of the Engineering Services Section, CCIW. An efficient static test cell has been designed to minimize concentration polarization resulting in surface inhibition. This is evident by mechanically controlling the surface turbulence at the membrane-solution interface. Other dynamic test cells currently in operation will undergo modification to increase their performance efficiency.

Studies using idealized salt systems have been conducted to ascertain the stability and variability of membranes with time. Surface inhibition resulting in fouling of membranes and the effectiveness of various chemical cleaning agents and methods are being examined. Results have indicated that enzyme active detergents are the most effective. Other chemicals have proved useful in cleaning membranes after some specific foulings. Physical cleaning techniques using air-water mixture pulsation flow and ultrasonics are also being studied.

Modification studies of the membrane surface, aimed at reducing inhibition, have been started. The evaluation of various wetting agents, their stability and lifetimes will be examined in idealized (pure water type) systems. A research program is underway in co-operation with Dr. H. Gesser of the University of Manitoba. Dr. Gesser holds several patents on techniques used to modify permanently the wetting angles through a physico-chemical modification of the membrane surface. The techniques require dry membranes, and as a result, an efficient and completely reversible process has been successfully developed here to prepare dry cellulose acetate membrane from a wet state.

Modification of Cellulose Acetate Membrane to Permi Wider pH Application and Greater Mechanical Integrity
(H.K. Johnston)

This study has been carried out in co-operation wit Dr. A. Rudin of the University of Waterloo, and the result are extremely encouraging. Part of the study has bee aimed at grafting chemically, certain appropriate pH resis tant and/or large mechanical strength polymers to th surface of an unshrunk cellulose acetate membrane.

Another part of the study is focused on the effect c cross-linking agents used to fabricate the reverse osmosi membranes. The use of these agents necessarily reduce membrane solubility and/or increases its strength. To inco porate the appropriate functional groups into the mem brane, a fundamental study of the chemical structure of th membranes has been underway, using the FMIR infrare spectroscopy technique. Part of the study has been cor ducted at the University of Waterloo by Dr. D. Irish.

The surface structure of cellulose acetate membran is also being evaluated using the electron microscopi technique at CCIW. Laser Raman spectroscopy techniqu are being studied by Dr. T. Davis (Water Quality Branc Ottawa), Dr. B. Morrow (Professor, University of Ottaw and Dr. A. Hardin (Post Doctorate Fellow, Ottawa).

Development of Improved Reverse Osmosis Membrane through Modification of Casting Conditions and the Appl cation of These Membranes to the Separation of Specifi Contaminants
(H.K. Johnston)

The first stage of this project has been the design an assembly of a critically controllable, explosion-proof castin room and the casting equipment. This has now bee completed, and attempts to improve the casting variables i terms of membrane performance are underway.

Good quality membranes of selected porosites can b fabricated to facilitate the study of the membrane separa tion criteria. The selective rejection of 19 heavy metal sal

of chlorides and nitrates by reverse osmosis membranes has been quantified and criteria for selective rejection have been proposed. Studies have now been extended to the alkali-salts where the criteria for both cation and anion rejections are being investigated.

An evaluation study of the ability of two different types of reverse osmosis membranes (cellulose acetate and aromatic polyamide) to reject different classes of phenols from pure water is near completion. This evaluation will be extended to both spiked and unspiked sewage systems. A sampling program to determine phenol levels in the sewage treatment plants throughout southern Ontario has been completed, and detailed sampling will be carried out at a plant that has been selected for this study. Classification of the phenols found in municipal effluent will also be undertaken with the assistance of Dr. A. Wolkoff at CCIW.

Evaluation of Reverse Osmosis Module Designs and Development of Efficient Pre-treatment and Post-treatment Techniques for Optimum Employment of Reverse Osmosis in Wastewater Renovation
(H.K. Johnston)

This project will be under the direction of a Post Doctorate Fellow. Equipment acquisition has been completed, and a module test system has been designed and assembled. All of the units are now functional and are being used intermittently to prepare large-volume samples for analysis and to obtain preliminary results for assisting the reverse osmosis pilot plant operation.

Additional studies are planned to improve pre-treatment techniques and, more importantly, to improve post-treatment and disposal techniques for the concentrate.

Treatment of Waste Treatment Plant Effluents by Reverse Osmosis—Canada-Ontario Agreement
(H.K. Johnston)

A complete reverse osmosis pilot plant has been designed and is mounted in a self-contained trailer to permit an on site evaluation of reverse osmosis as an advance wastewater treatment technique. The unit has been in operation almost continuously since April 1, 1974. The treatment of secondary sewage under a variety of controllable operating conditions has been studied. The unit functions within acceptable reliability and performance limits.

The short-term and long-term effectiveness of reverse osmosis as a treatment method and the operation and maintenance problems associated with operating this unit have been examined. The causes of membrane fouling and the methods of preventing and treating the fouling are being studied. Phase I of this program, completed in August, focused on the removal of nutrients and residual chemical additives from secondary sewage. Results indicate that the technique is effective. Phase II, which is expected to be completed in March 1975, has concentrated on heavy metal removal, as well as some toxic and persistent chemicals from secondary sewage. The removal of an additional 13 relevant chemical parameters (TOC, COD, TDS, etc.) by reverse osmosis is also being investigated. These investigations include the use of static and dynamic test cells. The studies have been regularly carried out in the laboratories to provide preliminary results in assisting the pilot plant operation.

Work is continuing on membrane fouling. Methods of treating and disposing of the concentrate obtained from the pilot process will be studied. The next phase of the program will emphasize the treatment of primary effluent, raw sewage and industrial wastewaters.

Removal of Trace Metals from Wastewater by Treatment with Lime and Discarded Automotive Tires
(A. Netzer)

A study was conducted to determine the effectiveness of removing trace metals from wastewaters. Prior to undertaking these studies, preliminary experiments were conducted to examine the potential of used rubber to remove aluminum, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc from aqueous solutions. These studies focused on the reactions between the metals and the various constituents of the rubber tire (e.g., sulphur, carbon black, synthetic rubber, antioxidants, fillers), especially the carbon black and the sulphur. In the experiments, the initial concentration of the stock solution of each metal was approximately 100 ppm. The percent reduction of metal by lime and discarded automotive tires varied from 0.1 ppm to >99.9 ppm and was pH dependent.

To explore more fully the potential of trace metals, continuous bench-scale studies were initiated using discarded automotive fires (DAT) in conjunction with lime. In the current studies, the removal of aluminum, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc solutions are being investigated.

The results indicate that discarded automobile tires can be used effectively to remove trace metals from aqueous solutions.

Advanced Physical-Chemical Treatment of Dye Wastes
(A. Netzer)

Industrial effluents containing dyes often create unpleasant sights in receiving waters. Furthermore, it is suspected that some dyes are carcinogenic. Since most dyes

are resistant to biological attack, conventional wastewater treatment techniques do not always achieve satisfactory colour, BOD and COD removals. It appears, however, that many forms of physical-chemical treatments can adequately treat these refractory pollutants.

The treatability of various commercial dyes used widely in the textile industries and effluents collected from several dyeing operations, were studied. The treatment processes investigated included biological oxidation, ozonation, activated carbon adsorption, synthetic resin adsorption, coagulation with lime and alum, and oxidation by hydrogen peroxide, potassium permanganate and sodium hypochlorite.

Some premetallized dyes were found to be toxic to the activated sludge. If ozonated prior to the activated sludge treatment, however, the wastes became more biologically degradable. Colour in most cases was easily removed by ozonation, hypochlorination and activated carbon adsorption. Unfortunately, hypochlorination sometimes created toxic substances, even after free chlorine was removed and the pH of the dye wastes was adjusted to neutrality. Hydrogen peroxide and potassium permanganate were found to be ineffectual in removing colour in nearly all cases. Depending on the chemical structure of the dyes, excellent removals were obtained by the weakly anionic, weakly cationic and non-ionic polymeric resins. These were used alone or were arranged sequentially. In these cases, the non-ionic resin is used to remove the bulk of the dyes, whereas the cationic and anionic resins serve as polishing steps. Alum and lime coagulation were observed to be capable of yielding high colour removals, although high dosage rates were necessary in some cases.

These studies demonstrate that dye wastes can be treated effectively by a number of physical-chemical means alone or in various combinations.

The Biotreatability of Industrial Textile Dye Wastes before and after Ozonation and Hypochlorination-Dechlorination
(A. Netzer)

Dye-bath effluents from various Ontario textile mills (e.g., from dyeing hats, rugs and yarn) without prior treatment were subjected to biological treatability tests, including batch extended aeration treatment. Subsequently they were classified as toxic or non-toxic and biodegradable, or non-biodegradable. These same effluents were treated by ozonation and hypochlorination-dechlorination and again subjected to biological treatability tests.

All of the non-biodegradable wastes became treatable after sufficient ozonation; following chlorination, however, only some of the wastes became biodegradable, whereas others remained unchanged. Furthermore, toxic wastes always became either non-toxic after ozonation, while toxicity was eliminated only in a few cases with chlorination. Therefore, it appears that ozonation can provide an effective pretreatment process for the biological waste treatment of refractory dye-bath effluents.

Colour and Heavy Metals Removal from Dye-Bath Effluents by Lime Precipitation
(A. Netzer)

Effluents from textile mills, carpet-dyeing and hat dyeing operations often contribute to industrial pollution. Not only are these discharges characterized by the presence of obnoxious and persistent colours, but they also contain a high concentration of organics and considerable amounts of such heavy metals as Zn, Cr, Hg, Pb, Cu and Co. An effective and economical reduction of the colour intensity and heavy metal concentration of these streams can often be achieved by lime precipitation.

Numerous different dye-bath effluents from various dyeing operations were treated with both massive lime dosages and controlled lime dosages to study the effect of pH on colour and heavy metal removals. Colour was determined by the procedure recently proposed by the American Dye Manufacturers' Institute.

Metal removals, except for chromium, were in the order of 90% or greater. Colour removals varied from excellent to poor, depending on the chemical species of the dyes present in effluents.

Treatment of Dye Wastes by Ozonation
(A. Netzer)

Industrial dye-house effluents present many environmental problems: they are often difficult to degrade biologically; they often contain large quantities of inorganic salts; they are sometimes highly coloured; they may contain heavy metals (such as mercury, lead, copper, zinc, chromium and nickel); and many dyes are toxic and possibly carcinogenic.

Experiments were conducted to assess the effectiveness of treating dye-bath effluents by ozonation alone, ozonation in conjunction with physical-chemical treatment and ozonation followed by biological treatment.

Excellent colour reductions were obtained with ozonation alone, but COD, TOC, heavy metal and inorganic salt levels remained essentially unchanged. Ozonation in conjunction with physical chemical treatment lowered the concentrations of heavy metals, TOC and COD. Ozonation prior to biological treatment provided a more biodegradable substrate for activated sludge organisms. Furthermore, ozonation tended to make the dye-house waste amenable to biological treatment.

zone Applications for the Treatment of Pulp and Paper ffluents
\. Netzer)

A practical solution was sought for the removal of fractive organic materials that impart colour to pulp and ıper mill effluents. Since many of these substances are ɔn-biodegradable, they often do not respond to conven-ɔnal biological wastewater treatment. It has been illus-ated that ozone is an efficient oxidant that can be used to ɛcrease the colour of these wastewaters. Moreover, ozone ɔes not require the high capital investments often required ır other treatment methods.

The kinetics of colour removal and the rate of ɔnversion of refractive compounds to biodegradable forms ere determined in this study. This information has been ɔplied to the design of an efficient ozone treatment ocess. The ability of ozone to improve biodegradability ıs been used to obtain the optimum combination of ological and chemical oxidation methods. This system of ing ozone to partially oxidize the colour bodies and then lowing bioxidation to complete the task, often results in wer capital and operating costs, while providing satis-ctory treatment.

sinfection of Secondary Sewage Treatment Plant Ef-ıents—Canada-Ontario Agreement
\. Netzer)

Since chlorinated organics may be toxic, alternative ethods of chlorination of secondary effluents are being vestigated under a joint project conducted by EMS, MOE d EPS. The EMS Laboratory is investigating the effects of sinfection of various secondary effluents under different nditions using ozone.

The effectiveness of ozonation was investigated at rious concentrations of bacteria, organics and suspended lids; ozone dosages; contact times; flow rates; and s-liquid ratios.

As part of this project, a comprehensive bibliography ozone disinfection was prepared and submitted for blication in the Canada-Ontario publication series.

Preliminary bench-scale experiments were conducted CCIW. Future planned studies for ozone use will termine the efficiency of disinfection under actual ntinuous plant operation at the Brampton Sewage eatment Plant. Special attention will be given to the struction of Salmonella and virus in the effluents. cteriophage-tracing will be part of the study.

The Characteristics and Treatment of Combined Sewer Overflows—Canada-United States Agreement
(A. Netzer)

Many municipalities rely on combined sewers to convey sanitary wastes, industrial effluents and storm waters to local sewage treatment facilities. Although combined sewer networks are generally more economical because of the reduced capital expenditures involved, diversion of the excess untreated wastes into receiving streams is necessary when the flow capacity of the system is exceeded.

It appears that efforts to control and minimize pollution from combined sewer overflows should include some form of treatment. Accordingly, two studies were initiated to evaluate possible treatment techniques. The first study involved the use of hydrocyclones and air flotation to produce an effluent of acceptable quality; the second study examined, in detail, the application of microstraining followed by ozonation. Pilot-plant and field investigations demonstrated that excellent reductions in biochemical oxygen demand, suspended solids and coliforms can be attained consistently by these methods at a reasonable cost.

Research into Novel Vessel Waste Treatment Systems—Canada-United States Agreement
(A. Netzer)

A literature review covering shipboard wastes has been completed, as part of the Novel Vessel Waste Treatment Program. A survey was conducted and information on treatment techniques has been received from more than 50 companies in North America and Europe. During 1974, a number of treatment units were inspected. These included a system developed by W.F. Walsh Co. of Montreal; the Elsan-Yarrow system sold by J.F. Misener and Co.; and the Jered Co. vacuum collection-incineration system.

Bench-scale research was conducted to examine the treatability of shipboard sewage by coagulation-flocculation, activated carbon adsorption and chlorination. In addition, a number of related projects have been conducted by independent consulting engineering firms. Among these projects were the characterization of shipboard sewage; the evaluation of odour-controlling chemicals; and a technical and economical review of existing shipboard waste treatment methods.

Oxychlorination of Organic Pollutants — Contract
(A. Netzer)

A study to determine the products formed during hypochlorous acid treatment of organic compounds (such

as phenols and aromatic compounds, which often pollute water supplies) is being conducted at the University of Waterloo under a research contract administered and coordinated by the Water and Wastewater Treatment Research Section. The study is designed to establish whether highly chlorinated products of potential biological toxicity are produced under the conditions employed in the chlorination and superchlorination of municipal water supplies, sewage effluents and industrial waters.

The study has been initiated in response to concern about the possibility of hydrocarbon pollutants (e.g., Bunker C and other types of fuel oils) forming polychlorinated aromatic hydrocarbons such as polychlorinated biphenyls, as a result of chlorination.

The organic compounds being examined are those that are often observed as contaminants of water supplies. The study includes product identification and synthesis (e.g., rate of hypochlorous acid consumption, product isolation and chlorine content, model compound study).

Induced Biodegradability by Photochemical Processes
(B.G. Oliver)

Studies to determine the effectiveness of the application of ultraviolet light to the treatment of wastewaters were conducted. In one study it was shown that irradiation with ultraviolet light is a viable alternative to chlorination for disinfecting secondary effluents from conventional activated sludge treatment plants. Recent literature indicates that the usual method for wastewater disinfection, chlorination, produces effluent that is often toxic to the aquatic environment. These studies have shown that ultraviolet light effectively and economically disinfects the effluent and produces an effluent that is less toxic to aquatic organisms.

The photochemical conversion of a variety of organic materials in water has also been studied. Biologically resistant organic chemicals such as benzene, toluene and ethers have been converted into readily biodegradable molecules, such as phenols, alcohols and aldehydes, by sensitized ultraviolet irradiation. In addition, the colours of various aqueous dye solutions have been significantly reduced by photo-oxidation and/or photo-reduction.

The Removal of Heavy Metals from Industrial and Municipal Effluents
(B.G. Oliver)

Studies were conducted in 1974 to determine heavy metal removal efficiencies and concentration points in conventional activated sludge treatment facilities. Thes studies illustrate that more than 75% of most metals can b removed by the activated sludge process. Notable excep tions are bismuth, nickel and strontium, which are remove to only a limited extent in the facilities studied. Metal removed by the process are concentrated in the sludge. It i proposed that some method should be developed to reclair the metals from the sludge before it is recirculated into th environment by land disposal.

The Decomposition and Conditioning of Sludge by Electro chemical Methods — Canada-Ontario Agreement
(B.G. Oliver)

The removal of heavy metals from industrial an municipal effluents, as part of the Canada-Ontario Agree ment Project, was initiated. The purpose of this study wa to remove and recover the heavy metals from sludges an sludge incinerator ash. Procedures comprising acid or basi leaching followed by electroplating and/or ion exchang and/or selective precipitation have been developed for th recovery of metals and nutrients from digested sludges an from sludge incinerator ash. Improvement of the processe and cost estimates will be evaluated in the last three month of the project.

The Removal of Asbestos Fibres from Surface Water
(J. Lawrence)

This study was undertaken because of the growin concern that ingested asbestos may be a potential healt hazard. Several water treatment methods were improve and evaluated with respect to the removal of asbesto Although simple sand filtration removes 80-90% of th fibres present, coagulation-flocculation with either ferri chloride or alum together with a polyelectrolyte reduce the concentration to below detectable limits ($<10^5$ fibres/l Fibre concentrations were determined before and afte treatment with a transmission electron microscope.

The Removal of Polychlorinated Biphenyls (PCB's) fro Sewage
(J. Lawrence)

The purpose of this project was to develop physical-chemical process to remove PCB's from ra sewage. The adsorption of PCB's was studied on a variety media, including activated carbons, polymeric resins, pol vinyl chloride (PVC) and polyurethane foams; PVC wa selected as the most efficient. A flow-through unit was use to demonstrate the feasibility of the final process.

Inland Waters Directorate, Ontario Region

WATER PLANNING AND MANAGEMENT BRANCH

In July, Mr. D.M. Foulds, Chief of the Water Planning and Management Branch, Ontario Region, was appointed Regional Director of Ontario Region, Inland Waters Directorate. Mr. N.P. Persoage, Head of the engineering staff in Burlington, was Acting Chief of the Water Planning and Management activities in Ontario.

The Branch includes the Great Lakes-St. Lawrence Study Office in Cornwall directed by Mr. D.F. Witherspoon and a suboffice, which is located in Niagara Falls.

The Water Planning and Management Branch carries out extensive studies related to water management problems in Ontario and is responsible for providing support to the International Joint Commission in various operational activities governing the control of the levels and outflows of the Great Lakes. Its members serve in various capacities on several Engineering Boards and Boards of Control established by the Commission and also on a number of joint Canada-United States International Committees.

In June 1974, responsibility for providing support to the International Lake Superior Board of Control, which regulates Lake Superior outflows, was transferred to the Great Lakes-St. Lawrence Study Office at Cornwall. The Burlington office assumed responsibility for providing support to the International Niagara Board of Control, which supervises water management operations in the Niagara River, and to the International Niagara Committee, which monitors the use of Niagara River water for power generation and scenic purposes in accordance with the Niagara Treaty of 1950 with the United States.

GREAT LAKES — LEVELS AND FLOWS

High water level conditions continued to occur on the Great Lakes during 1974. They showed, however, some improvement over the record high lake levels that occurred in 1973 on all of the unregulated lakes — Lake Huron, Lake St. Clair and Lake Erie. At the direction of the International Joint Commission, the International Lake Superior Board of Control continued to regulate the outflows of Lake Superior in a manner to provide relief from critical high water levels downstream without causing undue detriment to Lake Superior interests. During 1974, Lake Superior levels were about 7 inches above their long-term monthly means, and Lake Huron and Lake Erie, about 27 inches and 25 inches, respectively. Lake Ontario was about 22 inches above its normal seasonal maximum when it peaked in June, but it returned to near normal levels by the end of the year.

During the year, the Branch continued its program of informing shore property owners on the subject of high lake levels through correspondence, interviews by news media, and special meetings with water-use groups. In support of this activity, forecasts of the possible range of Great Lakes and Montreal Harbour levels for the ensuing six months were prepared every month and incorporated into a news release which accompanied the Monthly Water Level Bulletin issued by the Marine Sciences Directorate.

A film concerning the regulation of Lake Ontario, entitled "Not Man's to Command," was produced for the Water Planning and Management Branch in conjunction with the Public Relations Unit of CCIW. It was released in August and has had 54 public screenings, six television broadcasts, and two television cablecasts in 1974.

After the International Great Lakes Levels Board submitted its final report on the feasibility of further regulating the levels of the Great Lakes to the International Joint Commission in December 1973, Branch members continued to participate in the preparation of appendices to the final report. During October, November and December, the Commission held thirteen public hearings in Canada and the United States on the report.

Branch members played a major role in the work of a study team composed of Canadian and United States federal, provincial and state representatives appointed by the International Lake Superior Board of Control to carry out a feasibility study of remedial measures in the St. Marys Rapids to prevent the dewatering of crucial areas of the St. Marys Rapids under low-flow conditions and to resolve other fishery problems related to high flows and

velocities in the river (Fig. 30). A report, "The Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie," which was forwarded to the International Joint Commission in September, concluded that remedial works are feasible and preferable to other possible measures, both economically and environmentally.

On the Niagara River, Branch members participated in the activities of the International Niagara Committee, which was established by the governments of Canada and the United States to determine the amount of water available for purposes of the Niagara Treaty of 1950. Branch members also provided support to the International Niagara Board of Control, which reports to the International Joint Commission. During the year, a study was completed which revealed the effects of land fill operations at Fort Erie on the levels of the upper Niagara River and Lake Erie. Work also continued on another study to determine whether or not the manipulation of the levels of Chippawa-Grass Island Pool would affect the outflows of Lake Erie. At the close of the year, a field program was commenced to collect meteorological and ice data i support of the Lake Erie-Niagara River ice boom study.

Branch members also participated in the America Falls International Board Study to investigate and repo measures necessary to preserve and enhance the beauty c the American Falls at Niagara Falls (Fig. 31). The Boar submitted its report to the International Joint Commissio with a recommendation that no major works be undertake at this time. It also concluded that "the guiding polic should be to accept the process of change as a dynamic pa of the natural condition of the Falls, and that the proce of erosion and recession should not be interrupted." Th report is contained in one volume with seven appendice At the end of the year, a brief summary brochure w prepared for public distribution in advance of the Commi sion's public hearing on the Board's report, to be held ear in March 1975.

Branch representatives participated in the Canad Quebec Committee on Flow Regulations — Montre

Figure 30. St. Marys River control works at Sault Ste. Marie.

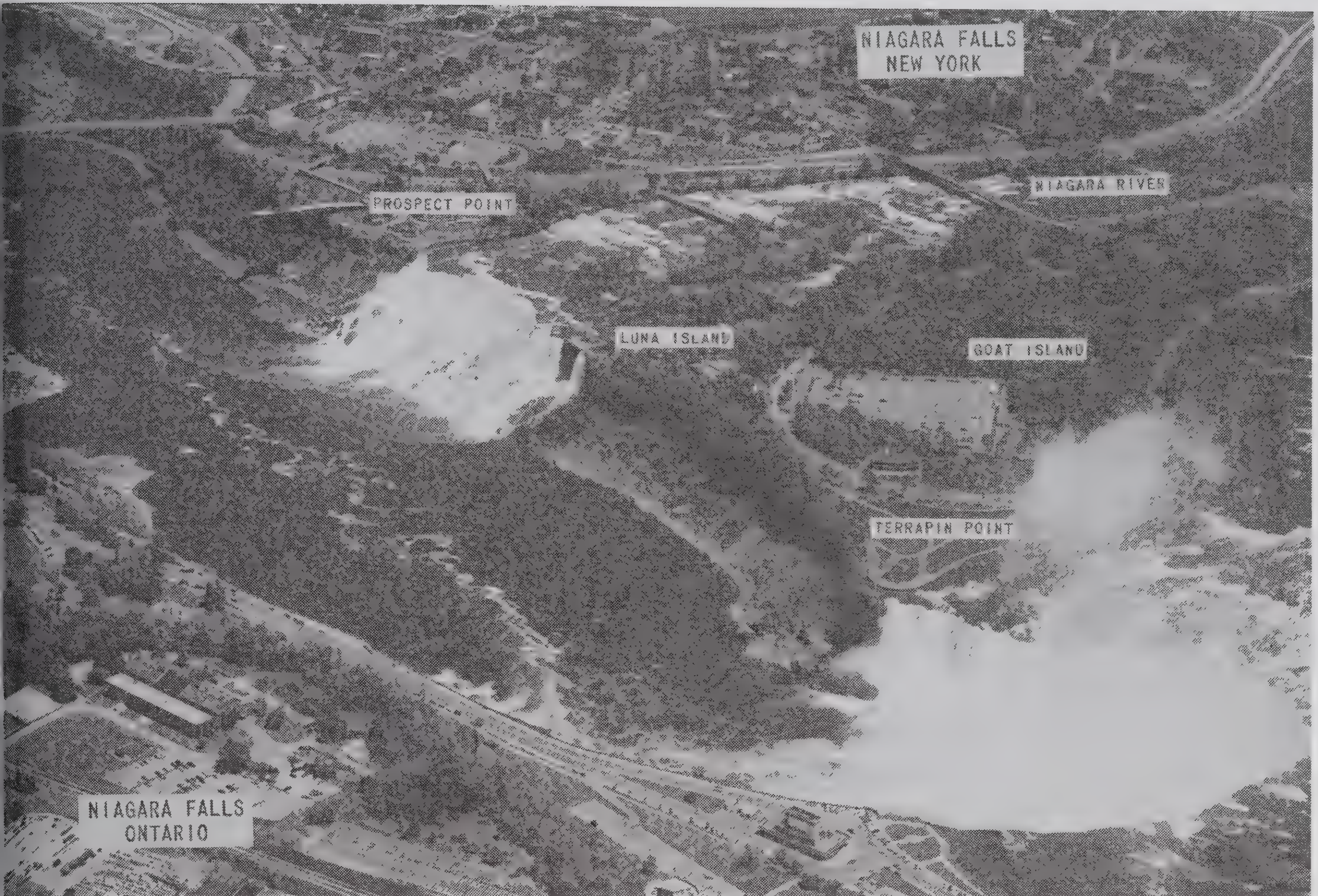


Figure 31. The American and Horseshoe Falls at Niagara. (Photograph courtesy of the Power Authority of the State of New York.)

egion. The Committee is conducting a two-year study to vestigate possible ways of reducing the frequency of high d low levels on the St. Lawrence River near Montreal.

GREAT LAKES – EROSION AND FLOODING

Although erosion and flooding problems in 1974 ere not as great as in 1973, they continued to be serious nce lake levels remained high. Branch members served in e work of the Coordinating and Steering Committee hich completed the Interim Report of the Canada-Ontario ore Damage Survey, with recommendations designed to hieve more effective management and planning within the eat Lakes coastal zone. Federal and provincial Review mmittees have been established to review the report and develop approaches to the problem of shore erosion.

The report of the Federal Interdepartmental Task rce on Shore Erosion, entitled "Shore Erosion on the eat Lakes-St. Lawrence System," was completed early in 74. This report, which compiled and analyzed all current ormation on the problem, had a wide distribution to the blic and to various government agencies.

ENVIRONMENTAL ASSESSMENT

The Branch actively participates in the recently instituted Environmental Assessment Review and Protection (EARP) Process under which environmental considerations are to be reflected in the planning and implementation of all federal actions. Initiated by the Screening and Coordinating Committee on the Ontario Regional EARP Process, a Coastal Process Group, chaired by the Director, Inland Waters Directorate, Ontario Region, was formed to review shore construction and dredging projects that may lead to serious modifications of the coastal process and of the local terrestrial and aquatic environments. These projects range from proposals for the placement of docks to those involving large water intakes. Since August 1974, twelve such applications have been reviewed. The Environmental Management Service is the lead agency for the review of these projects, and the Water Planning and Management Branch plays the coordinating role, ensuring that all concerns of the various Services of the Department are considered in the environmental assessment of the project.

Under the EARP Process, a Power Generation Group was also formed. It is expected that this Group will become

active in the forthcoming year in the areas concerning the environmental aspects of power plants.

BRANCH PROJECTS

The activities of the Branch include

1) preparation of a report by a Working Group involved in the study of Water Quality in the Upper Great Lakes,

2) producing forecasts of water surface temperature in the Lake Ontario-to-Montreal reach of th St. Lawrence River, with respect to scheduling th end of navigation and the installation of ice boom

3) studying backwater effects caused by ice jams i the lower St. Marys River at Sault Ste. Marie,

4) studying possible backwater effects caused by proposed landfill operation at Sault Ste. Marie, an

5) developing an improved regulation plan for Lak Ontario.

WATER QUALITY BRANCH

The role of the Water Quality Branch (Ontario Region) is 1) to operate a water quality monitoring and surveys program on lakes, rivers and streams in Ontario and on the Great Lakes to provide ambient water quality data, interpretive information and advice and 2) to operate an analytical chemistry laboratory for quantifying the characteristics and constituents of waters, wastewaters, sediments and aquatic organisms and advising on analytical methodology.

MONITORING AND SURVEYS SECTION

The Monitoring and Surveys Section is responsible for carrying out field programs in the Ontario Region and evaluating the data obtained from them. This task is divided into three major programs: Water Quality Surveys, Water Quality Monitoring, and Precipitation Chemistry. Since many of the projects are joint federal-provincial projects, the Section maintains and visits periodically a liaison office at the offices of the Ontario Ministry of the Environment in Toronto.

Late in 1974, a new responsibility was assumed by the Monitoring and Surveys Section for the operation of the IWD Great Lakes Water Quality Surveillance Program. The Section is now responsible for surveillance programs in both the Great Lakes and the interconnecting channels. It is expected that this will create better coordination between these closely related programs.

Water Quality Surveys Program

In addition to projects on the St. Marys River and the St. Lawrence River, which were continuations of projects initiated in 1973, new water quality surveys were initiated on the lower Niagara River and in the region of the proposed deep water harbour on the St. Marys River. These surveys, conducted with support from other units at CCIW, are coordinated with those of the Ontario Ministry of the Environment. Their objective is to assess the present wat quality of these channels 1) to determine compliance wit the objectives outlined in the 1972 Canada-United State Water Quality Agreement, 2) to identify trends in wat quality for evaluating the effectiveness of remedial program and 3) to locate any transboundary movement of pollutant

For the 1974 field season, a trailer was outfitted f use as a field laboratory for the determination of p conductivity, dissolved oxygen and soluble nutrients, a for filtration and preservation of other samples for lat analysis. Samples were brought back to CCIW for t determination of total nutrients, major ions, heavy meta pesticides, PCB's, phenols, chlorophyll *a* and cyanides.

As in 1973, three 5-day surveys were carried out the international section of the St. Lawrence River betwe Cornwall and Kingston. During each survey, 69 stations 31 ranges or cross sections of the river were sampled at depth of one metre.

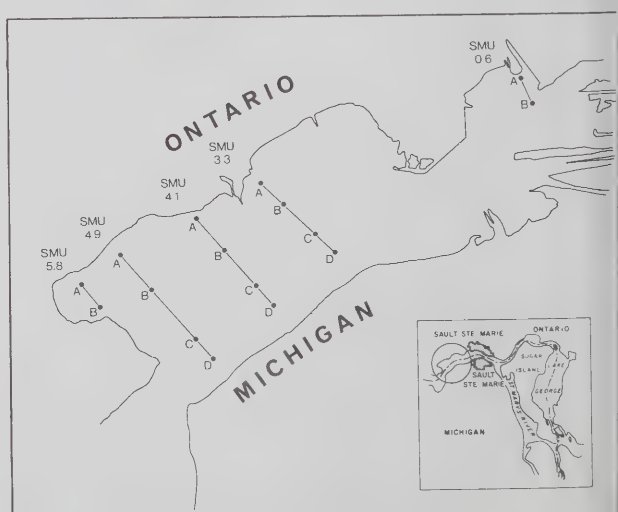


Figure 32. Sault Ste. Marie deep water harbour stations – 19

Three 5-day surveys of the St. Marys River were nducted; 34 stations in 7 ranges were sampled on each vey day. Three 3-day surveys were also made of the area the proposed Sault Ste. Marie deep water harbour. A p of the area is shown in Figure 32. The data from the ter survey will be used for environmental impact assessnt before construction and for comparison with future ta after construction. Table 10 contains a summary of ne of the data obtained from one survey.

Two new projects, a water quality survey project and hort-term variation study, were initiated on the lower agara River in 1974. An important objective of these jects is to refine the presently available loading estimates nutrients and toxic substances from the Niagara River o Lake Ontario. The survey project consisted of five lay surveys of the lower Niagara River during the period m July to December, alternating with complementary veys carried out by the Ontario Ministry of the vironment. Sixteen stations in three ranges were sampled each survey day.

The short-term variation study will be carried out h the aid of an automatic water sampling device igned and built by the Engineering Services Section of Scientific Support Division. The sampler was installed in 1974 at the water intake of the Niagara-on-the-Lake ter Treatment Plant. The sampler will be operational ly in 1975, providing data that will permit refined mates of loadings (Fig. 33).

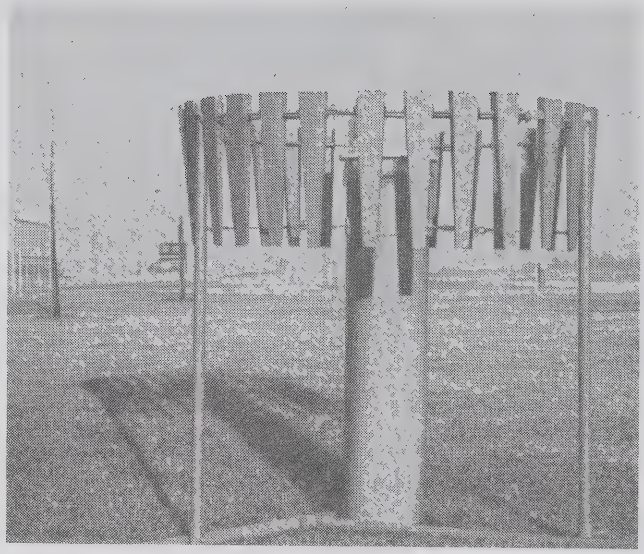


Figure 33. Precipitation collector used in the Water Quality Branch Precipitation Chemistry Network.

Water Quality Monitoring Program

The Water Quality Branch operates 28 water quality stations on rivers in Ontario and 54 stations on the Great Lakes, which are part of a network of about 600 stations across Canada. Samples from the river stations are presently being taken monthly or bimonthly by Water Survey of Canada or by local collectors. The Monitoring and Surveys Section coordinates the sampling and data handling for this program. Plans are being made for future quarterly

Table 10. Sault Ste. Marie Deep Water Harbour Data – July 13, 1974

ion ber	Secchi depth (m)	Specific conductance 25°C (μmhos)	Nitrate + nitrite (mg/l-N)	Ammonia (mg/l-N)	Total Kjehdahl nitrogen (mg/l-N)	Soluble phosphate (mg/l-P)	Total phosphorus (mg/l-P)	Silicate (mg/l-SiO_2)	Chloride (mg/l-Cl)	Sulphate (mg/l-SO_4)
J-0.6-A	1.5	114	.245	.590	.860	.002	.014	2.60	4.3	6.0
B	4.5	93	.240	.019	.150	.001	.020	2.15	1.6	3.1
J-3.3-A	3.0*	93	.210	.004	.130	.001	.017	2.05	1.2	3.2
B	4.0*	93	.230	.003	.110	.001	.009	2.10	1.2	3.0
C	6.0	93	.240	.003	.120	.001	.009	2.15	1.2	3.0
D	5.5	95	.240	.002	.130	.001	.008	2.15	1.2	3.2
J-4.1-A	1.5*	92	.200	.011	.120	.001	.007	1.95	1.2	3.2
B	3.0*	92	.220	.005	.120	.001	.008	2.10	1.2	3.1
C	7.0	92	.225	.003	.120	.001	.009	2.10	1.4	3.0
D	5.0	92	.230	.004	.120	.001	.007	2.15	1.6	3.0
J-4.9-A	4.0	93	.200	.002	.120	.001	.007	2.05	1.2	3.1
B	4.0*	93	.205	.008	.110	.001	.006	2.10	1.4	3.6
C	8.0*	92	.225	.004	.110	.001	.011	2.15	1.2	3.1
D	4.5	93	.215	.006	.120	.001	.011	2.10	1.2	3.1
J-5.8-A	3.5*	93	.200	.004	.120	.001	.007	2.05	1.2	3.3
B	2.5*	93	.190	.010	.140	.001	.011	2.05	1.2	3.1
1	4.2	94	.220	.042	.169	.001	.010	2.12	1.5	3.3
dard deviation	1.8	5	.017	.146	.184	.00025	.004	0.14	0.8	0.7

chi disc on bottom

sampling at river stations by the staff of the Section to permit determination of those parameters for which more sophisticated sampling and preservation techniques are required.

Precipitation Chemistry Program

The operation of 22 precipitation chemistry stations in the Great Lakes basin was continued with emphasis on the upper Great Lakes. The program of rain collection and analysis on the major research vessels was maintained. The bulk of the shipboard samples collected in 1974 was from the Lake Huron-Georgian Bay region.

A new buoy-mounted precipitation sampler was designed and built in 1974. Three identical collectors were mounted on a standard meterological buoy, which was moored off the tip of the Bruce Peninsula.

The Section was involved in the development and awarding of a contract to two consulting firms for the evaluation of data from the precipitation chemistry program and the estimation of the effects of atmospheric inputs on the chemical budget of the Great Lakes. Since the awarding of the contract, the Section has been co-operating with the contractors by supplying precipitation chemistry data and has also participated in monitoring the contract.

ANALYTICAL SERVICES SECTION

The Analytical Services Section consists of three laboratories: an Inorganic Analysis Laboratory, an Organic Analysis Laboratory, and a Ships Support Laboratory. This Section provides analytical support for projects undertaken not only by the Monitoring and Surveys Section, but also by other groups at CCIW, other Units of the Inland Waters Directorate, and, to a lesser extent, other segments of the federal government. During 1974, the Section supported a total of 67 programs and was particularly active in support of IJC programs, such as programs of the Upper Lakes Reference Group and the Pollution from Land Use Activities Reference Group, and the River Survey programs.

More than 25,000 samples were analyzed during 1974, including 11,000 wastewater samples and about 6000 samples from surveys of the Great Lakes and interconnecting channels. Approximately 170,000 tests were conducted on these samples, including 27,500 tests performed on board ship and some 6000 in field laboratories.

Some of the major projects in which the Section participated are listed here.

Upper Lakes Survey

Analytical support was provided for all of the seve survey cruises on Georgian Bay and Lake Huron, whic were conducted during 1974. This work was related to Ta 12 of the Canada-United States Water Quality Agreeme and was designed to provide chemical data for the annu report to the IJC. In addition, biota and sediment sampl collected during a special survey cruise of Lake Superic Lake Huron and Georgian Bay, were analyzed for a numb of toxic substances.

Samples were also analyzed on behalf of the Unit States Environmental Protection Agency Region V Labo tory in Chicago for its Winter Surveys on the upp Great Lakes. There were frequent exchanges of samp among the laboratories during the year for quality cont purposes.

Other Great Lakes Projects

Analytical support was provided to a number of otl projects related to the Great Lakes including

1) lower Great Lakes surveillance in which laboratory staff participated in two surveillar cruises on Lake Ontario and one on Lake Erie a provided analytical support to another 15 crui on the lower Great Lakes,
2) field and laboratory support to the Monitor and Surveys Section for surveys carried out on Niagara, St. Lawrence and St. Marys Rivers and the deep water harbour site at Sault Ste. Marie,
3) field and laboratory support to the Great La Biolimnology Laboratory, the Microbiol Laboratory and the Lakes Research Division the Point Source Study which was conductec Nipigon Bay at Red Rock, Ontario, and
4) analysis of precipitation samples collected by Monitoring and Surveys Section.

Wastewater Treatment Studies

Analytical support was provided to a number projects related to wastewater treatment which inclu the removal of heavy metals from wastewater by ads tion; the evaluation of the efficiency of wastew treatment by reverse osmosis; and a vessel wastew treatment study.

Other Projects

The NTA Monitoring Program continued with a ysis of samples from Lake Ontario and Hamilton Harb from the Western Region, and from municipal w supplies that were sampled early in the year.

The Section extended its analytical capabilities to include sediment analyses and chlorophyll *a* analyses. Automated methods were set up for the determination of cyanides and low-level total Kjeldahl nitrogen. An Autolab System IV computing integrator was installed in the Organic Analysis Laboratory to achieve a high degree of automation in the chromatographic analysis of pesticides. High-speed liquid chromatography is also being used for the clean-up step in organic analyses.

The Section collaborated with the Microbiology Laboratory in a study of degradation of fecal sterols. The study showed that mercuric chloride was far more effective as a preservative than sodium hypochlorite.

Sample Exchange

The laboratory participates in several continuing sample exchange programs including those conducted by the Upper Lakes Reference Group Committee for Data Quality, the Water Quality Branch, the United States Environmental Protection Agency, the Canadian Committee for Pesticide Use in Agriculture, and the Pollution from Land Use Activities Reference Group. The latter three agencies' programs involve organic parameters including chlorinated hydrocarbon and organophosphorus pesticides and phenoxy acid and triazine herbicides.

The laboratories have also participated in a number of special exchanges, including a field exchange with the Ontario Ministry of the Environment, an International Association of Geochemistry and Cosmochemistry intercalibration study, and special studies on metals in sludge and sediments, and on PCB's and chlorinated hydrocarbons in fish.

SPECIAL SERVICES SECTION

The Special Services Section carries out technical programs of national interest to the Water Quality Branch, which maintains laboratories in Calgary, Moncton and Vancouver as well as at CCIW. The programs include development of test methods and updating of the laboratory manual; operation of a quality control program among the laboratories; special advice and assistance to the laboratories regarding analytical problems and instrumentation; and provision of standards for organic compounds difficult to obtain through normal channels.

The Section consists of two laboratories — a Quality Control Laboratory and a Method Development Laboratory.

Quality Control

The quality control function is carried out primarily through two major programs.

The Inter-Regional Quality Control Program

In this program samples are distributed every month to the Water Quality Branch laboratories only for analysis of a complete range of parameters (major ions, physical properties, nutrients, trace metals, pesticides and other organics). The results are compared and the laboratories are notified of any discordant results. The results are analyzed to determine any small, but consistent, biases over a period of time. The program proved very useful during its first year of operation in 1974 by revealing a number of unsuspected problem areas that could have been serious if they had remained unnoticed.

The National Quality Control Program

In this program samples are distributed to a group of about 40 laboratories involved in water analysis across Canada including federal, provincial and municipal government laboratories, universities and private companies. The following studies were conducted during 1974:

Study No. 11 — boron, fluoride and silica,

Study No. 12 — cadmium, chromium, lead, manganese and nickel, and

Study No. 13 — copper, lead, zinc, cobalt, iron and aluminum.

The laboratory also provides assistance to the regional laboratories in matters related to quality control and participates in other projects such as IJC committees on quality control.

Method Development

Method development activities this year were primarily directed to methods for the determination of metals and nutrients in sediments, the determination of carbamate pesticides and the confirmation of organophosphorus and chlorinated hydrocarbon pesticides.

Important projects finished during the year include

1) a new approach to the confirmation of chlorinated hydrocarbon pesticides using a solid matrix for derivatization, which was further extended to apply to over a dozen pesticides in fish, water and sediment extracts. This approach is more rapid, sensitive and comprehensive than other existing methods. It has been adopted by several outside laboratories, as well as the by the Water Quality Branch laboratories,
2) a method for the determination of chlorinated hydrocarbon pesticides and PCB residues in sewage, developed for the needs of two EPS projects in the Ontario Region,
3) a method for the confirmation of the identity of

eight organophosphorus pesticides at sub-ppb levels, which is the most comprehensive and sensitive method available to date,

4) a method for the determination of inorganic, organic and total phosphorus in sediments by digestion with different acids followed by automated colorimetric determination of the phosphate produced,

5) a semi-automated procedure for the determination of mercury in sediments, currently in use at CCIW,

6) a procedure for the analysis of heavy metals in precipitation using atomic absorption spectrophotometry with a heated graphite furnace. The method is more sensitive than conventional flame atomic absorption and is needed when samples collected are too small for the conventional extraction procedure, and

7) the preparation of bulk sediment standards for quality control and method development use. Twenty-three samples of 1-5 kg were prepared for use as standards.

WATER SURVEY OF CANADA

The basic responsibility of the Ontario Region of the Water Survey of Canada is to maintain an inventory of the water quantity of the water resources in Ontario. The District Office is located in Guelph, with suboffices in Ottawa, North Bay and Sault Ste. Marie.

Operations of the network in the western and northwestern part of the Province are carried out by the Manitoba District of the Western Region, Inland Waters Directorate. In addition to the water quantity planning and monitoring programs, the Ontario Region, in co-operation with the United States Army Corps of Engineers, is responsible for monitoring programs on interconnecting channels in the Great Lakes and specifically in the Niagara River, where considerable work is done for the International Niagara Board of Control.

Operation and maintenance of water level stations on the Great Lakes are carried out for the Central Region, Marine Sciences, Ocean and Aquatic Affairs, and a limited sampling program is conducted in co-operation with the Water Quality Branch.

A review of the functions and operations of the Sections in the Ontario Region follows.

FIELD OPERATION SECTION

This Section consists of three prime work areas: hydrometric gauging stations, Great Lakes water levels, and sediment surveys.

A hydrometric network of 377 active gauging stations was operated in 1974. An extensive field program for collecting discharge measurements to determine or verify water level discharge relationships was carried out. This included an approximate total of 2700 measurements and six new gauging installations. Water level data extraction from recorder charts was made with a d-Mac Pencil Follower, and data were processed on an IBM 370 computer located at the University of Guelph Computer Centre. Sampling programs on behalf of the Water Quality Branch and Groundwater Division and the Water Resources Branch were also completed. One hundred and ninety water quality samples and two groundwater discharge measurements were collected and forwarded to the respective division involved.

Field surveys and slope sections were made at a number of stations on the Grand River watershed. Data from the survey were used to establish the extension of stage-discharge curves to determine the high flows experienced in May 1974. Isolated thunderstorms created record flows at nearly all stations with damage worth millions of dollars caused by flooding. Discharge measurements obtained were records in all areas, and in some cases, flows exceeded Hurricane Hazel.

In March 1974, an intense network of highly instrumented stations was constructed in the upper Duffin Creek basin. The program is part of an Environmental Impact Study of the proposed site of the new Toronto International Airport. A total of 13 stations, instrumented with 9 pumping water samplers, 8 thermographs and 1 telemark, monitor the upper Duffin and west Duffin Creek basins for surface flow, water quality and sediment transport.

The water monitoring program is integrated with a program for the North Pickering Community Development Project, which is conducted by the Ontario Ministry of the Environment.

A total of 41 water level stations located on the Great Lakes and St. Lawrence River were maintained for the Central Region, Marine Sciences, Ocean and Aquatic Affairs. A Telex Data Retrieval System is now installed and functioning at a minimum of one location on each of the

Great Lakes. The Kingston water level station was relocated to accommodate the part of the 1976 Olympics Program to be held in the Kingston Harbour. A temporary water level installation was constructed at Douglas Point to collect water data to evaluate the amount of fluctuation in levels of Lake Huron.

An annual sediment sampling program involving 12 stations in the regional network was completed. During 1974, 3200 bottled samples, 17 suspended sediment discharge measurements and 50 bed-material samples were collected. On the upper Duffin Creek basin, 264 water quality and sediment samples, 9 bed-load samples and 11 suspended sediment discharge measurements were taken.

Sediment discharge computations for 1973 data were computed and approved for four stations by District personnel; the remainder were forwarded to the Sediment Section of the Applied Hydrology Division in Ottawa for completion. Extensive field surveys were carried out at the Conestogo and Parkhill Reservoirs as part of a Reservoir Study program to be completed by the Sediment Section in Ottawa. Staff of the Ontario Conservation Authorities, Sediment Section of Applied Hydrology Division and the Ontario District of the Water Survey of Canada conducted the surveys.

SPECIAL STUDIES AND SURVEYS SECTION

In 1974, this Section maintained a number of measurement programs on the interconnecting channels of the Great Lakes.

The programs completed were

1) discharge measurements of the lower Niagara River taken from the Robert Moses cablecar to verify the Ashland Avenue gauge stage-discharge curve and discharge measurements at the cableway above Queenston to determine the extent of weed effect at the Ashland Avenue gauge,
2) discharge measurements to calibrate ten sluices of the Lake Superior control structure,
3) discharge measurements of the St. Lawrence River at Cornwall to determine the distribution of flow around Cornwall Island,
4) discharge measurements of the upper Niagara River to determine whether or not the outflow of Lake Erie is affected by the regulation of the Grass Island Pool, and
5) measurement program on the Niagara River at the outlet of Lake Erie near the Peace Bridge, as part of a critical depth study.

NIAGARA RIVER STUDIES AND CONTROL

This Unit participated in the functions of both the International Niagara Working Committee and International Niagara Board of Control. Responsibilities for the coordination of the International Niagara Committee and Lake Erie outflow — Lake Ontario inflow monthly reports were transferred to the Water Planning and Management Branch, Ontario Region, Inland Waters Directorate, effective October 1974.

The Leading Edge Flowmeter functioned during most of the year; it malfunctioned during the backwater study in November 1974. Major repairs were required, and the test was postponed until 1975.

DATA CONTROL SECTION

This Section is comprised of two main working groups: the Hydrometric Data Compilation and Quality Control group and the Data Review group.

In 1974 our major publication "Surface Water Data — Ontario — 1973" was compiled, quality-checked, printed and distributed to various data users throughout Ontario. A large percentage of the computation and publication procedures are now automated and in 1974, the publication was available three months ahead of distribution in previous years. This has reduced the amount of data requests handled to approximately 13,000 station years of record from the 22,000 of the previous year. Not included in the data were miscellaneous requests for river cross sections, velocity profiles, extremes for period of record, etc. During the year, 499 separate requests for data were provided to fifteen different agencies; these do not include numerous telephone requests for which data were supplied orally.

The Data Review group, which is involved in a systematic review of all data collected to 1970, has completed approximately 40% of the total planned program. The initial phase of the program was concentrated in the northern basins of Ontario and progressed to the southern and southwestern Georgian Bay basins. Work involved the examination and revision, if necessary, of the data.

NETWORK PLANNING AND FORECASTING SECTION

Some of the major projects completed during the year follow:

1) an Inter-District Flow Forecasting Seminar was

hosted by the Ontario Region. Various methods used were examined and organizations using flow forecasting in Canada were recognized,

2) data for five Ontario river basins were prepared and forwarded to Ottawa for inclusion in the *UNESCO World Catalogue of Very Large Floods,*

3) a paper entitled "Hydrometric Instrumentation" was prepared and presented in the *Summary Report of the Perch Lake Evaporation Study.* The paper was presented at a Symposium held at the Atomic Energy of Canada site, Chalk River, and

4) a federal-provincial cost-sharing agreement.

Environmental Protection Service

Environmental Protection Service

The Environmental Protection Service (EPS) was formed to ensure that the federal government's legislation, regulations and guidelines concerning the quality of the environment are approached in a manner consistent with national policy and enforced under appropriate circumstances. The Environmental Protection Service is involved in the development of guidelines and regulations, in the identification and solution of pollution problems, in problem surveillance and monitoring, and in the development and demonstration of waste treatment technology. It draws on expertise from the Resource Missions of the Department for the criteria necessary to develop effective regulations, guidelines, and codes of good practice and for the research required to support EPS responsibilities.

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION DIVISION

The Technology Development and Demonstration Division, Technology Development Branch, Water Pollution Control Directorate, is responsible for the conception, development and implementation of technical development programs related to water pollution control for industrial and municipal wastewaters across Canada. The Division not only undertakes bench-scale and pilot-scale studies in its laboratories, but also participates in field demonstration projects at industrial sites.

To fulfill the mandate of the Technology Development Branch, EPS established a program at the Wastewater Technology Centre at CCIW. The Wastewater Technology Centre (WTC) is located in a two-storey building at the north end of the CCIW site. The building houses laboratories and provides 1395 m^2 (15,000 sq ft) of working area for a wide variety of modular wastewater and sludge treatment process equipment.

The Wastewater Technology Centre bases its program priorities on the requirements of the Abatement and Compliance Branch of the Water Pollution Control Directorate, inputs from the various regional branches of EPS and provincial environmental organizations, and federal, national and international commitments.

The staff of the Wastewater Technology Centre is organized into three main sections: the Process Development Section, the Laboratory Services Section and the Facilities Services Section, all supported by administrative personnel.

PROCESS DEVELOPMENT SECTION

The Process Development Section comprises four Units organized along process lines: the Biological Processes Unit, the Physical Processes Unit, the Chemical Processes Unit and the Soil Processes Unit.

Biological Processes Unit

This Unit is responsible for developmental work on biological processes used to remove components such as BOD, suspended solids and toxicity from municipal and industrial wastewaters. A Bioassay group, responsible for determining the fish toxicity of untreated waste streams and treated process effluents, was part of the Biological Processes Unit until October, when it was transferred to the Laboratory Services Section.

Biological Treatment of Kraft Bleachery Effluent

A joint federal-industrial project involving the operation of a pilot-scale two-stage activated sludge system treating kraft bleachery effluent was conducted at Eddy Forest Products, Espanola, Ontario. For comparison purposes, a conventionally loaded single-stage system was operated parallel with the two-stage system. Emphasis was placed on an assessment of the capabilities of the activated sludge systems for the reduction of acute toxicity to juvenile rainbow trout. Process efficiencies were determined and engineering design parameters were developed.

For the two-stage activated sludge system, volumetric loadings of 3.8 and 1.6 kg $BOD_5/m^3 \cdot$ day (235 and 100 lb $BOD_5/1000$ $ft^3 \cdot$ day) provided BOD_5 reductions of 67% and 90%, respectively. The achievement of similar BOD_5 reduction required the operation of the single-stage system at volumetric loadings of 1.6 and 0.7 kg $BOD_5/m^3 \cdot$ day (100 and 45 lb $BOD_5/1000$ $ft^3 \cdot$ day).

To compare the toxicity removal capabilities of the single-stage and two-stage activated sludge systems with

respect to fish, logarithmic probability distribution plots of median survival time (MST) in 100% effluent were developed (Fig. 1). The MST for the untreated bleachery waste is shown for comparison.

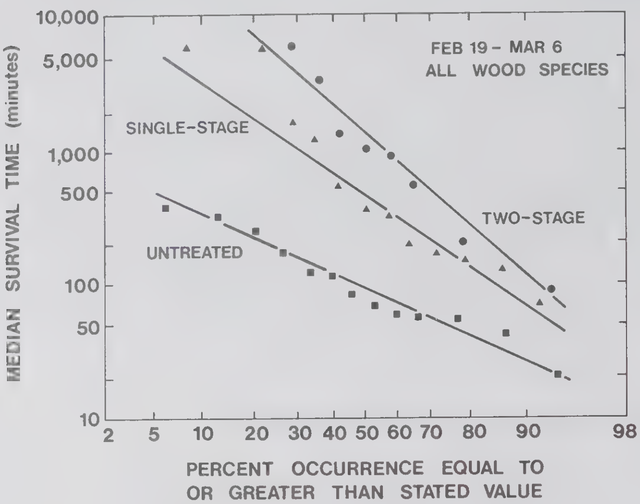


Figure 1. Probability distribution for median survival time for treated and untreated kraft bleachery effluent.

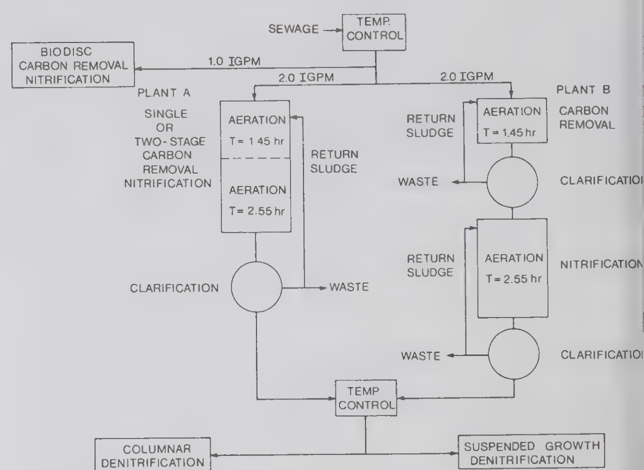
Even under organic-loading and volumetric-loading conditions considerably greater than for the single-stage systems, the two-stage system achieved consistently higher toxicity removal.

Effluents from the single-stage and two-stage activated sludge systems treating kraft bleachery effluent did not meet the toxicity requirements specified in the Pulp and Paper Effluent Regulations (1971), i.e., there must be 80% survival of rainbow trout after 96 hours in a 65% effluent solution. Preliminary bench-scale studies indicate, however, that the addition of alum and powdered activated carbon to the aeration cells of either activated sludge system will produce an effluent that meets the toxicity requirements specified in the 1971 regulations. Before a program is established to improve rates of chemical addition to the activated sludge system, bench-scale studies will be conducted to identify the chemical constituents of bleached kraft mill effluent that are the major contributors to fish toxicity and to determine the extent to which these toxic components are removed by the treatment process.

Biological Nitrification-Denitrification Studies

The joint research project initiated with McMaster University in 1972 was continued throughout 1974. Detailed studies were carried out to examine various flow and process configurations for biological nitrification.

The primary objective of this phase of the program was the evaluation of combined sludge and separate sludge, carbon-removal nitrification systems for the treatment of municipal wastewater. Specific alternatives evaluated were single-stage combined sludge, two-stage combined sludge and two-stage separate sludge systems. Pilot-scale reactors, as shown in Figure 2, were operated under pseudo steady-state conditions over a range of loading conditions and temperatures. Parallel reactor operation provided a mechanism for direct and sensitive comparison of operational and kinetic data.



NOTE: 1.0 IGPM = 4.55 L/MIN

Figure 2. Flow diagram of 7200 Igpd nitrification-denitrificatio pilot plant.

For each alternative, the degree of nitrificatio achieved was found to be dependent on the sludge age (i.e. solids retention time) in the system. Separate sludg systems removed a significantly greater amount of filterabl TKN than the combined sludge systems at equal system solids retention times. In each system, the nitrification rat was found to be more sensitive to temperature than th rates of organic carbon removal, particularly at lowe temperatures. To achieve complete nitrification at temper atures approaching 5°C, a minimum solids retention time o ten days appears necessary regardless of the alternative selected.

A second phase of the nitrification-denitrificatio project involved the operation of a rotating biologica contractor for nitrification and an upflow packed colum for denitrification. The rotating biological contractor wa operated parallel with a two-stage activated sludge syster with intermediate clarification to compare rates c ammonia conversion for temperatures ranging from 5°C t 25°C. Nitrification rates for the fixed film reactor wer found to be less temperature sensitive than for th suspended growth system.

Two upflow denitrification columns were operated t determine whether a high void fraction plastic packir could be used effectively to minimize liquid distributio and blockage problems. Tracer studies showed that the

as extensive short circuiting within the column, which was tributed to an accumulation of biological solids. The rtial blockage of the column resulted in highly variable nitrification rates.

efinery Effluent Toxicity Balance Study

A joint federal-provincial-industrial project was rried out at the Shell Refinery in Sarnia to quantify, in rms of toxic units, the toxicity contributed by the dividual refinery process effluents. The Bioassay group nducted bioassay tests on site using the mobile bioassay boratory and the mobile storage trailer (Fig. 3). Shell anada, Imperial Oil Enterprises, and the Ontario Ministry the Environment participated in the project.

gure 3. Mobile bioassay and storage trailer at the Shell Refinery, Sarnia.

The method of expressing the toxicity of the waste-ater was to measure the 96-hr LC50, the lethal concen-ation for 50% of the fish in a 96-hour period. The ciprocal of the 96-hr LC50 designated as the toxicity ncentration, Tc = (100/96-hr LC50), and having units of xic units, was used for the comparison of the results. For specific crude unit that had a number of contributing eams, the toxic concentration multiplied by the pro-rtion of the total system flow was determined for each ntributing stream. If a toxicity balance existed, the sum the toxic units of individual streams within the system ould equal the toxic units of the total effluent from the stem.

To establish a toxicity balance, the flow, chemical mposition and 96-hr LC50 were measured for each finery process effluent, the total effluent from each crude iit, the combined effluent from the two crude units, fluents at intermediate points in the treatment system d the final treatment system effluent. Results from each finery process effluent were combined to establish hether a toxicity balance existed for the individual crude iits or the combined effluent from the two crude units, ., the total oily water refinery effluent prior to treatment.

Treatment plant process effluents were included in e study to provide a quantitative measure of the toxicity removed by each process of the treatment system, i.e., the oily water separator, air flotation unit and biological oxidation unit. Reductions in toxicity were highly variable and inconsistent; the biological oxidation unit was the exception, as it produced a relatively constant percentage toxicity reduction. It was established that the complete treatment system was capable of reducing the toxicity to the level specified in the *Petroleum Refinery Effluent Regulations and Guidelines* published by EPS in 1974.

Biological Treatment of High-Strength Pulp and Paper Mill Effluents

Bench-scale studies were undertaken to determine whether the activated sludge process could be used to treat the effluent from a neutral sulphite semi-chemical (NSSC) pulp and paper mill that has an extensive water reuse program. Effluents obtained from the Domtar NSSC mill at Trenton had a BOD_5 of approximately 12,500 mg/l and a total dissolved solids (TDS) of 45,000 mg/l. Although the high-strength effluents were biodegradable, they could not be treated successfully in either a single-stage or two-stage activated sludge system. Oxygen deficiencies, excessive foaming and bulking sludge were the major operational problems.

Similar bench-scale activated sludge studies have been carried out at the Consolidated-Bathurst Research Centre in Grand'Mère, Quebec. In this joint project, high-yield bisulphite spent cooking liquors having a BOD_5 of 15,000 mg/l and a TDS of 45,000 mg/l were treated in both single-stage and two-stage activated sludge systems. Solid-liquid separation problems resulted in unacceptable performance of the activated sludge systems. Following dilution of the spent sulphite liquor to 2% TDS, the two-stage activated sludge system with a total aeration time of 1.5 days could be operated with an apparent improvement in sludge settling characteristics.

Physical Processes Unit

This Unit conducts research and development work on physio-chemical treatment processes for the removal of deleterious and toxic constituents from industrial and municipal waste streams. Active areas of concern include the development of design and operational criteria for the dewatering of municipal waste sludges, investigation of physical-chemical treatment (PCT) processes for small communities and the treatment of wastes from base metal mining, metal-plating and steel industries.

New Brunswick Acid Mine Drainage Treatment Project

In 1972, a joint federal-provincial-industrial study was initiated for the development of mine and mill wastewater treatment technology in the base metal mining

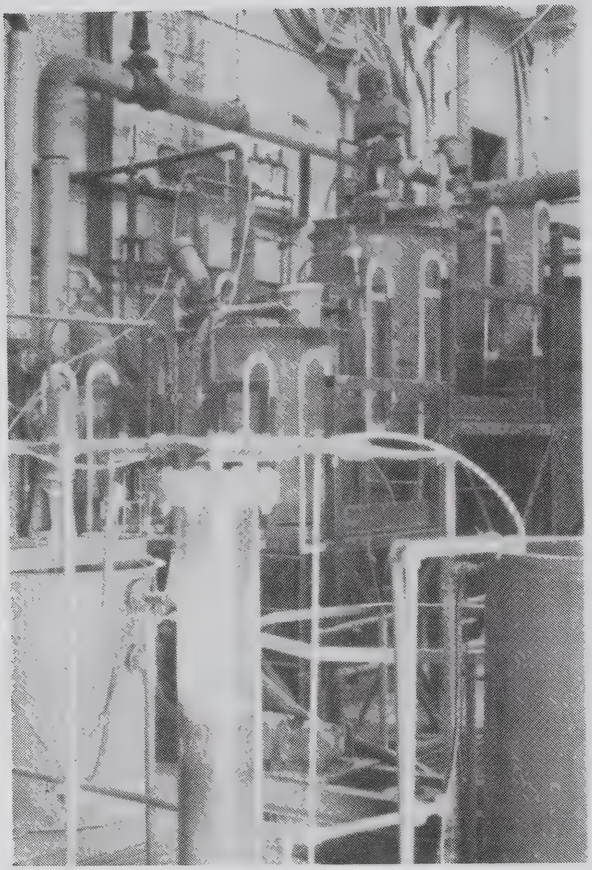


Figure 4. Physical-chemical pilot plant for treatment of acid mine drainage.

industry. Two pilot demonstration plants were established at the Brunswick Mining and Smelting Corporation site in northeastern New Brunswick (Fig. 4). One of the pilot plants incorporates state-of-the-art technology for the treatment of acid mine waters. Unit processes include neutralization and precipitation, polymer flocculation, sedimentation, sludge-handling and effluent-polishing. Effluent metal concentrations obtained from several mine waters using state-of-the-art technology are summarized in Table 1.

Table 1. Heavy Metal Concentrations (Total Metals) of Some Mine Waters after Physical-Chemical Treatment

Mine water	Pb (mg/l)	Zn (mg/l)	Cu (mg/l)	Fe (mg/l)
Clarification Brunswick mine smelting (BMS) no. 12	0.30	0.42	0.04	0.36
Heath Steele	0.11	0.65	0.08	0.51
BMS no. 6	0.30	0.52	0.06	0.54
Clarification and sand filtration Heath Steele	0.10	0.14	0.02	0.22

Figure 5 illustrates the excellent effluent-polishi achieved with sand filtration for removal of suspend solids carried over in the clarifier effluent.

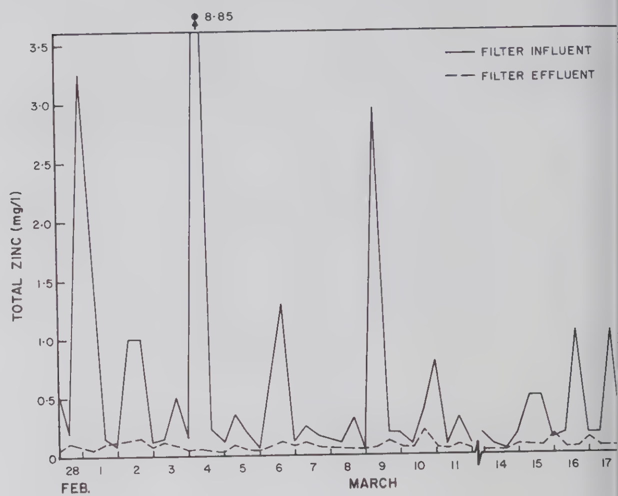


Figure 5. Zinc removal by sand filtration.

A pollution problem also existed from the milling the ores containing a high sulphur content. Reduced sulph compounds (thiosulphate and thionates), generated in grinding and separation processes, were escaping from mill in the tailings pond overflow. This caused a signific pH depression in the receiving water when indigenous b teria oxidized these thiosalts to sulphate. Studies carried at the Wastewater Technology Centre established the fe bility of two treatment processes: biological oxidat using a rotating biological contactor (RBC) and chemi oxidation in a stirred tank reactor using ozone. The R (Fig. 6) is currently in operation at the mine site demonstrate this technology.

Physical-Chemical Treatment for Small Communities

Sewage treatment plants that serve small, isola communities of a few thousand people or less, typic present unique design and operational problems that not usually encountered in large plants. Many of difficulties are directly related to the highly variable orga and hydraulic loads under which small plants must oper In addition, small plants generally receive very li maintenance and monitoring. To ensure improved consistent effluent quality, a program on the developm and demonstration of physical-chemical treatment syst for small communities was initiated.

One experimental phase consisted of a chem coagulant addition to an extended aeration pilot plant.

A second experimental program was conducted determine the effects of chemical additions to raw sew (including powdered activated carbon) on the prim treatment process efficiency.

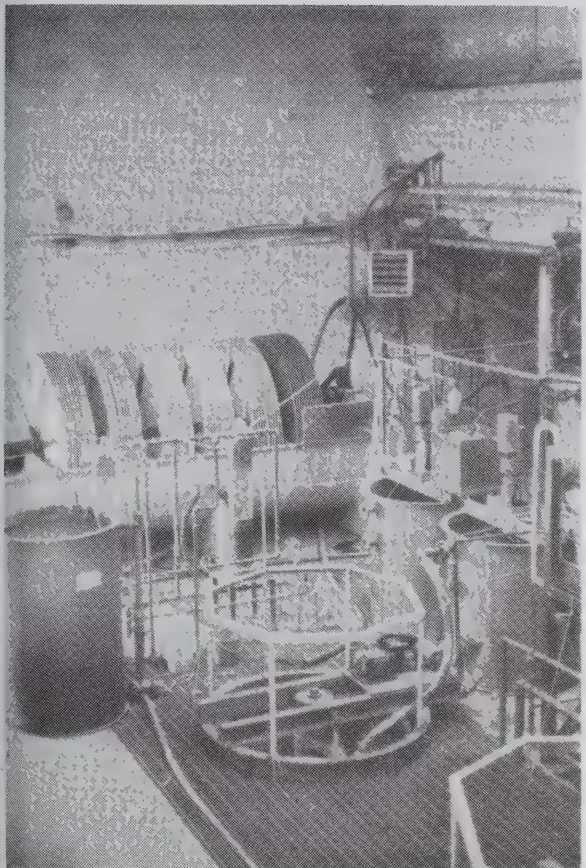


Figure 6. RBC pilot plant for thiosalt treatment.

A third experimental program, which is now in ogress, involves conventional physical-chemical treat- ent. This pilot plant includes a programmed control stem which enables us to simulate the variations in ganic and hydraulic loading that are encountered in "real e" situations (i.e., small communities). As presently nceived, it includes the unit processes of chemical agulation, solids separation, adsorption and sand fil- ation (Fig. 7).

udge Dewatering Process Development Studies

The Sludge Treatment Process Development Program examining municipal waste treatment with respect to ysical and chemical properties of the sludges. These operties are correlated with the efficiency of various idge dewatering processes. At the same time, this program designed to examine the control variables and scale-up chniques of the following sludge dewatering processes: cuum filtration, centrifugation, dissolved air flotation, avity thickening and pressure filtration.

To meet these objectives, the Wastewater Technology ntre developed a sophisticated analytical laboratory for easuring physico-chemical properties and established a obile bench-pilot scale sludge dewatering facility (Fig. 8).

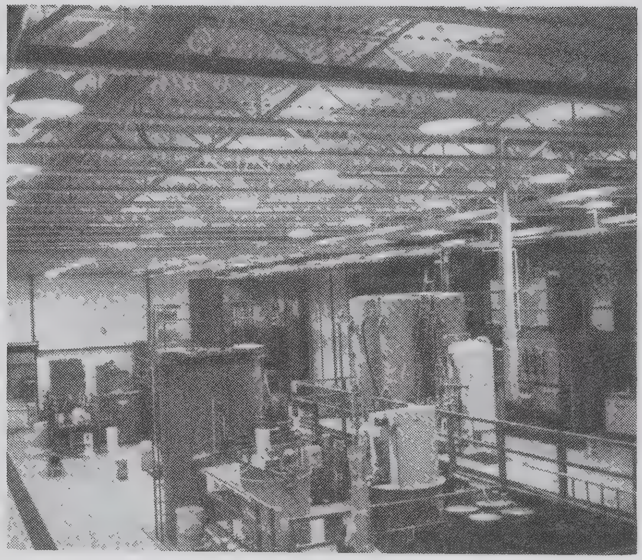


Figure 7. Physical-chemical treatment pilot plant for small communities.

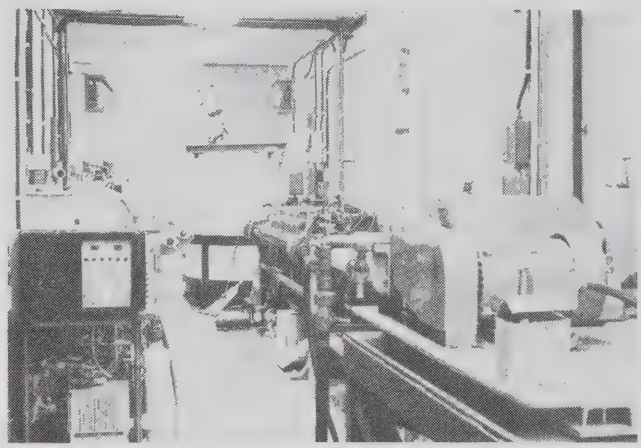


Figure 8. Bench-pilot scale mobile sludge dewatering facility.

During the past year, many sludges (waste activated, raw primary, mixed primary and waste activated, and digested) have been dewatered using the various processes available.

Chemical Processes Unit

This Unit carries out developmental work using chemical processes for the removal of undesirable and potentially harmful constituents from effluent waste streams. Of immediate concern and involvement is the removal of phosphorus by chemical means.

Full-Scale Phosphorus Removal Studies

Full-scale phosphorus removal studies, employing alum addition to the activated sludge treatment plant, were conducted at C.F.B. Trenton, Ontario. Treatment plant

performance with respect to BOD_5, total phosphorus, and suspended solids removals was closely monitored under base-line (no chemical addition) conditions and at various alum addition levels.

The required alum dosage for phosphorus removal was 3.0 mg/l to 3.5 mg/l as Al, and the most effective addition point was at the exit end of the aeration basins.

Sludge Incineration and Chemical Recovery

A field station was set up at the C.F.B. Borden, Ontario, Wastewater Treatment Plant for pilot-scale studies on sludge dewatering, incineration and chemical recovery. Multiple-hearth and rotary kiln incineration of alum, ferric chloride and slum sludges were investigated. The feasibility of recovering and recycling lime-iron from the incinerator ash was also explored. The calorific values of several sewage sludges are presented in Figure 9. A strong correlation between sludge volatile solids content and calorific value is evident.

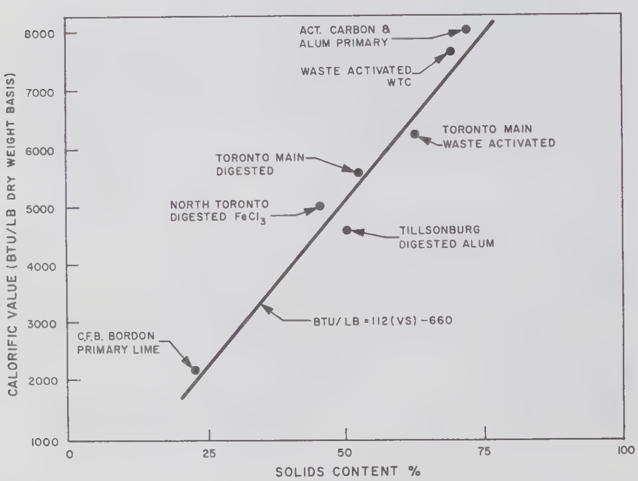


Figure 9. Calorific-value volatile-solids relationship for selected sludges.

Polychlorinated Biphenyls in Domestic Wastewater

A survey of polychlorinated biphenyl (PCB) concentration in the raw wastewaters from 33 Ontario municipalities was conducted. In addition, detailed investigations of the fate of PCB's during conventional secondary treatment were performed at the Hamilton Wastewater Treatment Plant. PCB concentrations in raw wastewaters ranged from less than 0.1 ppb to 1.8 ppb, of which the industrial areas of Hamilton, Toronto and Windsor exhibited the highest levels. The primary treatment facilities that were surveyed removed on the average 50% of the PCB load, whereas secondary plants averaged 66% removal. PCB concentrations in digested sludges ranged from 0.6 ppm to 76.6 ppm (dry weight).

As expected, the predominant mechanism of PC removal during wastewater treatment is by concentration the primary and/or waste activated sludge streams.

NTA Degradation in a Receiving Stream

Since the Canadian detergent reformulation legi lation of 1972, NTA use in laundry detergents h increased. Considerable research effort has been devoted determining the environmental implications of NTA (e.g biological wastewater treatment degradation studies ar investigations of potential metal transport problems). T date, limited studies have been carried out to ascertain tl extent of NTA degradation within the receiving water.

In this investigation, NTA levels in Grindstone Cree the receiving water for the Waterdown, Ontario, Wastewat Treatment Plant were closely monitored to determine t degree of NTA degradation under summer and wint conditions. Sampling stations were established at six poir over the five-mile stretch of stream between Waterdov and Hamilton Harbour. Samples were collected under tv influent wastewater NTA loading conditions (i.e., 16-20 m and 8-16 mg/l) during summer and winter. Steamflow a temperature were closely monitored.

During the summer period when NTA remo through the treatment plant was in excess of 95%, diluti and degradation combined to give downstream NTA co centrations consistently less than 10 μg/l. In the win when stream temperatures were in the range of 0.5°C 3.0°C and NTA removal through the plant was less th 45%, downstream NTA concentrations as high as 125 μ were encountered. At the same time, levels at the mouth Grindstone Creek in Hamilton Harbour averaged 40-50 μg

Activated Sludge Degradation of Metal NTA Complexes

A bench-scale batch activated sludge study v conducted to determine the biodegradability of N complexes with aluminum, cadmium, calcium, chromiu copper, iron, mercury, nickel, lead and zinc. Degradat rates were evaluated at NTA levels of 8 mg/l and 16 mg/ H_3NTA, temperatures of 5°C and 15°C and various me concentrations.

It was determined that the NTA complexes with Ca, Cr, Cu, Fe, Pb and Zn degraded readily at first-or degradation coefficients ranging from 0.04 hr^{-1} to 0.10 h The heavy metal NTA complexes of Ni, Cd, and Hg degra poorly (i.e., degradation coefficients less than 0.02 hr^{-1})

These experiments, reinforced by observations other related studies, lead to the conclusion that buildup of NTA in the aquatic environment, even du low winter temperatures, is extremely unlikely.

evelopment of Predictive Models for Phosphorus Removal

The objective of the study was to determine whether correlation between influent wastewater characteristics nd phosphorus removal by chemical addition exists and, if o, to define this relationship.

Available data from treatability studies were ana-yzed, but were found to be inadequate for the development f significant relationships. These data, however, were sup-lemented by conducting additional jar tests at 20 sewage eatment plants across Ontario. Each jar test study onsisted of ten jar test runs using all three chemicals (ferric hloride, alum, lime) and, at the same time, analyzing the aw sewage for 28 parameters. The statistical model evelopment is still in progress.

oil Processes Unit

The areas of concern for this Unit are investigations f the suitability of various soil systems for the disposal f sludges and effluents on land, reclamation of acid mine ailings, as well as leachate characterization from sludge-soil ystems, the role different soil systems play in removing arious constituents, and the fate of heavy metals.

eclamation of Acid Mine Tailings

This study was initiated to establish the reclaiming apability of lime precipitated sewage sludges on acid mine ailings. Improvement of the rate of lime sludge application or establishing successful vegetation on mine tailings was a urther objective.

Attempts to grow clover plants on the surfaces of udged tailings were unsuccessful. It was found, however, at reed canary grass can be supported on sludged acid ine tailings provided that the rate of sludge application is 300 t/ha (dry solids).

isposal of Chemical Sewage Sludges on Land

To assess the environmental effects of chemical wage sludge disposal on land, a long-range study program as been undertaken with the following objectives:

- to investigate the maximum loading rate of chemical sewage sludges on agricultural soil systems,
- to determine the biochemical degradation of organic and inorganic sludge constituents,
- to measure the uptake, transport and accumulation of nutrients, minerals and metals through plant, leachate and soil systems, and
- to monitor the survival and transmission of indicator bacteria in soil and leachate.

To date, results show that increasing rates of sludge application up to 900 kg TKN/ha have resulted in an increased yield of total dry matter. The highest rate of lime and iron sludges applied to silt loam soil produced 9% and 15% higher yields, respectively, than the 13.2 t/ha from the commercial fertilizer treatment.

Although concentrations of nitrate nitrogen in the leachate were higher at the highest rates of application, differences among the various types of sludges were statistically insignificant. Overall levels of total nitrogen in the leachate were not considered potentially hazardous to groundwater supplies. The grass grown on the lysimeters was identified as the major sink of N, P, K and heavy metals from all of the three sludges applied.

Recycling of Liquid Sewage Sludge on Dredged River Sand

A study to assess the impact of applying primary digested sewage sludge at different surface loading rates to dredged river sand was completed.

This field installation consisted of four plots, comprising a total area of 0.4 ha. Each plot was polyethylene lined with an underdrainage collection and discharge piping system covered by a 1.20-metre depth of dredged sand.

With plot number 1 as the control, primary digested sludge was applied to plot numbers 2, 3 and 4, at surface loading rates of 1560, 2860 and 6190 kg TKN/ha, respectively. Soil tests were conducted on the sludged plots in March 1973 and April 1974 to assess the fertility of stabilized sands. The organic matter content of the sands had increased by approximately 0.8% over control with the highest sludge application. A deficiency of Ca, Mg and K in sludged plots proportionally to the amounts of sludge applied was also determined.

Total dry matter yields of mixed grasses harvested during the period from April to December were 67, 1175, 1125 and 2170 kg/ha for plot numbers 1, 2, 3 and 4, respectively.

Increased amounts of sludge applied resulted in increased concentration of various sludge constituents in the plant tissues. In this study, metal toxicity to the grass was not observed.

State-of-the-Art Review of Potato-Processing Wastewater Treatment and Reuse

A review of the literature pertinent to the production and treatment of potato-processing wastewaters was conducted. An outline of the potato-processing industry in Canada was given, showing production emphasis in the french fry and potato chip branches. Typical unit operations

were described; wastewater volumes, COD, BOD_5 and suspended solids loads were estimated from published data; load contributions from the various unit operations were compared. Existing methods of in-plant treatment were described.

Characteristics of the final combined raw effluent stream, as reported in the literature, were compared to estimates from a recently conducted Environment Canada survey of the industry in Canada. Operating results of end-of-line treatment by various physical and biological systems were discussed. The use of sand filtration and the potential use of advanced waste treatment methods, such as reverse osmosis, were noted.

Leaching of Radioisotopes from Uranium Mine Tailings

This project attempts to quantify the leachability of radium and thorium radioisotopes from the uranium mine tailings and sediments. Containers, 0.3 m in diameter, providing a 1-metre depth of tailings, have been set up at the WTC to leach tailings under varying conditions. The leachates are being analyzed for radioisotopes.

The tailings and barium-laden sediment were obtained from the Elliott Lake area.

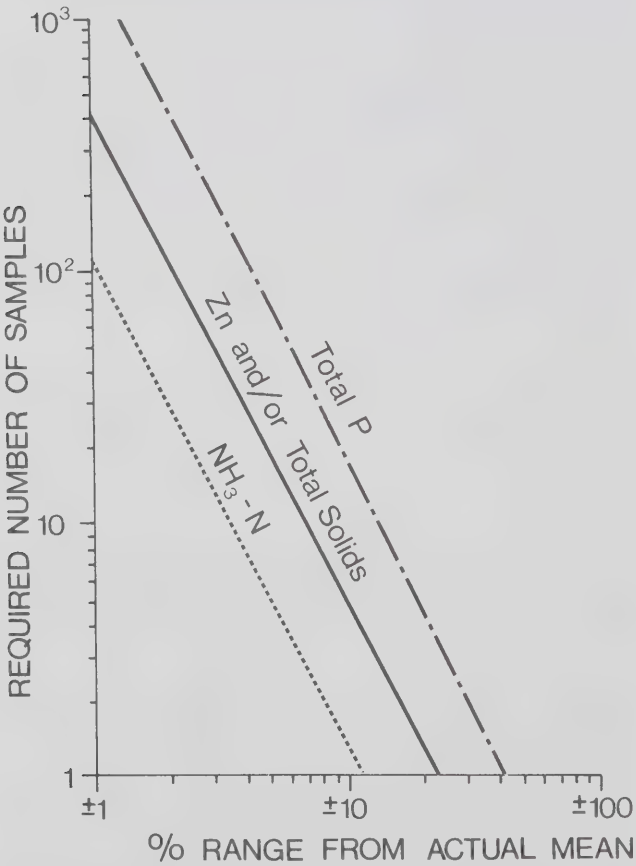


Figure 10. Relation of required number of samples to predict the mean concentration within a specified range.

Variability of Sewage Sludges, Sampling Methodolog[y] Development

Knowledge of the existence of a high variabilit[y] in the nutrient and heavy metal content of digeste[d] sewage sludges led to the design of an intensive samplin[g] experiment to define more precisely the nature of th[e] variability and to provide a basis for practical impl[e]mentation of future sampling programs. The initial pha[se] has involved sampling at a lightly industrialized munic[i]pality (Simcoe, Ontario WPCP).

Conclusions of the initial phase of the program a[re] that ammonia nitrogen (NH_3-N) and total phosphor[us] (Total P) were found to be the least and most variab[le] parameters, respectively. Figure 10 relates the requir[ed] number of samples to be analyzed to a predetermine[d] specified tolerance that is acceptable in the determinati[on] of an actual parameter mean concentration. As shown [in] Figure 10, five random grab samples were required [to] predict the mean total solids concentration within ±10% [of] the actual value. It was determined that zinc concentratio[n] followed the same curve as total solids, meaning that [its] relative variability was identical. It is emphasized that th[e] prediction depends on random grab sampling. Some statis[ti]cally significant mean parameter concentration differenc[es] were observed among the study days. Large differenc[es] were not evident and appeared to be irregular events.

Fish-Processing Waste Screening Technology

A project to demonstrate screening technology [for] the fish-processing industry was completed in co-operati[on] with the EPS staff of the Atlantic Region. This stu[dy] demonstrated the attainable levels of solids removal [for] herring, shrimp and red fish processing waste. Prelimina[ry] data analysis indicates 40%, 60% and 30% suspended sol[ids] (SS) removal, respectively, when a number 25 mesh scre[en] (after coarse screening) is used. Screening of a combin[ed] herring and shrimp waste resulted in 50% SS removal.

LABORATORY SERVICES SECTION

From a total of 29 projects, requests for analyti[cal] services continued at about the same number as in 19[73]. Approximately 31,000 samples were received requir[ing] about 96,500 parameters. Of these parameters, one h[alf] were for metal analysis and the rest consisted mainly [of] various forms of nitrogen, phosphorus, carbon and sulph[ur]. Sample types continued to be as varied as in 1973, but w[ith] an increase in the products from the various progra[ms] concerned with sludge disposal or treatment. New types [of] samples included crop roots, flour (from wheat grown [in] lysimeter studies) and incinerated sludges, all of wh[ich] required studies to determine the best possible technic[ues] of analysis.

The main analytical investigations during 1974 were s follows:

1) automation of COD determination for samples containing solids,

2) use of ammonia and chloride specific ion electrodes,

3) determination of sulphur in crops,

4) organic carbon in sludges,

5) effects of various grinding machines on crop analysis, and

6) complex and simple cyanides in industrial wastes.

The interlaboratory comparative study on heavy ıetals in sludge samples continued, with an increase in articipating laboratories including two laboratories from ıe United States.

ioassay Group

In October, the Bioassay group, formerly part of the iological Processes Unit, was transferred to the Laboratory ervices Section.

At the WTC the Bioassay group, comprised of two ermanent biologists, supplemented by contract employees ıd/or Co-op students to meet program demands, occupies small base laboratory, which has a capacity for 8 simultaneous tests. A 32-foot mobile bioassay laboratory ailer was purchased and equipped to carry out six fish ioassays simultaneously. In addition, a 45-foot effluent orage trailer was purchased and equipped with four .4-m^3 (1200-gal) and two 2.7-m^3 (600-gal) effluent storage ınks and associated cooling units to hold industrial fluents at 4°C for the duration of a toxicity study, sually 96 hours.

Programs in which the Bioassay group has partici- ated are

1) toxicity removal studies on pulp and paper mill effluent both in the field at Espanola and at the WTC,

2) toxicity balance at the Shell Refinery, Sarnia,

3) assessment of toxicity of samples from selected textile and food-processing plants, and

4) treatment of bisulphite liquors.

pproximately 1500 tests were carried out in the course these programs.

In addition, Bioassay staff were deeply involved in oviding information to committees that were establishing xicity requirements for effluent regulations.

FACILITIES SERVICES SECTION

The Facilities Services Section operates and maintains the various pollution control units in the Wastewater Technology Centre and ensures that services for new processes are assembled to meet design criteria generated by the Process Development Section.

During 1974, a fully automated 19.4 m^3/day (30 Igpm) physical-chemical pilot treatment plant was commissioned. One of the design features is the ability to program diurnal fluctuations of both organic and hydraulic loading, as experienced under "real" operating conditions. The plant features lime treatment, recarbonation, sand filtration and carbon adsorption.

During the year, the staff of the Facilities Services Section ensured the continuous operation of the various pilot plant modules, such as the nitrification-denitrification pilot plant, as well as the physical-chemical module used for phosphorus removal under various operating modes, e.g., polymer and powdered activated charcoal addition.

The 13.6-m^3/day (30,000-Igpd) extended aeration pilot plant, located outside of the Wastewater Technology Centre, was in continuous use, providing a source of sludge for the ongoing sludge treatment process development studies. Modifications to facilitate maintenance and upgrade safety conditions were made during 1974.

The temperature-controlled bioassay facilities were doubled in size to provide space for an industry-government commissioned study by Dr. J. Sprague and associates of the University of Guelph. This program investigates the sublethal toxic effects of petroleum refinery effluents on fish.

Increased demands of the raw sewage supply main have attained the design capacity of the existing system. Design modifications to accommodate the additional demands are under consideration. Similarly, demands on the power supply system have resulted in the installation of a 600-kVA transformer with plans for an early completion of the secondary distribution system.

During 1974, an extensive safety program was undertaken, resulting in the installation of catwalks, handrails, platforms, harnesses and breathing apparatus.

In addition, service and maintenance programs for the various pilot plant components were initiated, resulting in the streamlining of the operation of the Facilities Services Section and ensuring more reliable operation.

Some of the additional commitments of our senior staff included serving on the various Canada-Ontario Agreement Committees (Board of Review, Technical Committee,

Research Sub-committee, Land Disposal on Sludge Sub-committee, Storm and Combined Sewer Sub-committee and Technology Transfer Sub-committee). Membership was also held on the IJC Research Advisory Board's Sub-committee on Water and Wastewater Treatment Research.

In February, the staff of the WTC hosted a NATO/ CCMS meeting. Seven countries were represented in the discussion of the status of the physical-chemical waste treatment demonstration pilot plant now under construction in the United Kingdom at Colehill. The United Kingdom is the pilot country for this project; Canada is or of the co-pilot countries. Our staff also participated in th second Canada-Ontario Agreement Workshop held in th fall in Toronto, which had as this year's theme, "Slud Handling and Disposal." In addition, we participated in workshop on physical-chemical treatment, "Activate Carbon Adsorption in Water Pollution Control," in Ottaw

A summary of technical reports completed during th year and papers presented at various technical conferenc is provided in Appendix B.

ENVIRONMENTAL EMERGENCY BRANCH

CENTRE OF SPILL TECHNOLOGY

The working staff of the Centre of Spill Technology (COST) presently includes two development engineers, one biologist and one technician.

Many of the projects were undertaken in liaison with consultants, industrial companies, universities and other government agencies. The following projects were either completed or in progress in 1974:

1) The testing and evaluation of oil spill skimmers was continued. During this year, the evaluation of skimmers was carried out in Bedford Basin. The Bedford Institute of Oceanography supplied vessels and coxswains for the operation. A consultant contracted to COST undertook the evaluation and analytical aspects of the test. The skimmers tested were the JBF DIP 2001, the SLICKLICKER MK II, the SLURP and the OIL MOP.
2) The testing and evaluation of oil spill treating agents continued. This was a three-part program undertaken by COST. The first part was the completion by Concordia University of the study on "Sinking Agents." The results of this study are being used to prepare *Guidelines on the Use of Sinking Agents.* Sorbents available commercially in Canada were evaluated by an industrial company under contract. The EPS Physiology Testing Laboratories at the Bedford Institute of Oceanography have tested commercial oil spill dispersants in accordance with the acceptability criteria of the *Guidelines on the Use and Acceptability of Oil Spill Dispersants.* All of these studies will be incorporated into the *Environmental Emergency Technical Handbook* of the Environmental Emergency Branch.
3) The Canada Centre for Remote Sensing developed a laser fluorosensor to detect oil spilled onto water. To assist them in the field trials of this unit, COST provided the ground support for an airborne experiment conducted at CCIW.
4) In conjunction with the EPS Northwest Region, t problems associated with spillage from petroleu product storage areas in the Northwest Territories we investigated. Particular attention was given to t dyking practices at the storage areas. This study w undertaken by an industrial company under contra A report entitled *Review of Petroleum Spill Co tainment Dykes in the North* was issued in Septemb
5) At the request of the EPS Pacific Region, CO provided information on the revision of the Burra Inlet (Port of Vancouver) oil spill countermeasu report. A workshop was held later to discuss this rep in detail. COST presented papers on "Dispersant and "Shoreline Clean-up" at the workshop.
6) The Hydrology Research Division, IWD, undertoo study for COST on the migration of hydrocarbo spilled into the sub-surface soils. Field work was do at Flin Flon, Manitoba, to ascertain the lateral a vertical movements of hydrocarbons. Research underway to develop methods to remove the hyd carbon from the soil and to prepare guidelines on treatment of oil spilled into the substrata.
7) A joint IWD-COST study on the feasibility of tagg oil by halogenated polyaromatics was undertaken. report on the results of this study was issued December 1974.
8) To assist field operation people in determining the s movements at an oil spill, COST commenced a stu to assess the development of simple spill movem model and, if possible, provide an algorithm guiding countermeasures operations.
9) A limited pilot project was started in all EPS regi under COST's guidance to develop seasonal envir mental maps. These maps would provide informat to "clean-up" crews and contingency planners ecological and human protection priorities, poten danger areas and resources available.
10) A study undertaken by COST and consultants initiated to determine the hazardous materials Canada, the methods of counteracting accidental s

of these materials and the state of preparedness to control these spills. The results of this study are due in early 1975 and will form the basis for future technology development work in this area.

11) Toxicity and effectiveness testing of commercial spill dispersants was undertaken for COST by the EPS Physiology Testing Laboratory at the Bedford Institute of Oceanography. On the basis of these tests, workshops were held in Burlington and Ottawa to formulate DOE policy on dispersants and to advise the Ministry of Transport (MOT). As a result of these meetings, a joint DOE-MOT dispersant field testing program is being planned for 1975.

12) COST is providing to the Department of Supply and Services engineering and scientific advice on the development of a prototype "OSCAR" oil spill recovery device. This unit is now under construction and will be evaluated by COST in 1975.

13) In the Beaufort Sea Project, a joint undertaking between DOE and the oil industry, COST is the oil spill countermeasures study coordinator for EPS. This study is reviewing the methods and techniques required to detect, contain, recover and dispose of an oil spill resulting from an accidental well "blow-out" at an offshore exploratory well in the Beaufort Sea. The work commenced in late 1974 and is to be completed by the end of 1975.

14) In co-operation with EPS Ontario Region, COST undertook the oil spill countermeasures program of "Operation Preparedness," a study to develop methods involving all of the aspects of oil spills on the St. Clair River. The study required locating sites on the St. Clair where oil could be contained and recovered and the actual field testing of containment and recovery equipment and techniques at each location. The field evaluations were commenced in August 1974. A report containing the results of the field program and the recommendations for future equipment requirements and countermeasures techniques was prepared and issued by COST in November 1974. Planning is now underway for the field testing of these recommendations in 1975.

15) In 1974, COST investigated oil spills in northern Ontario and the Gulf of St. Lawrence and participated in actual clean-up operations at the IMPERIAL SARNIA spill at Brockville, Ontario.

16) Papers were presented by COST at the Water Pollution Conference (Toronto), the Arctic Petroleum Operators Conference (Whitehorse) and the Conference on Prevention and Control of Oil Pollution (San Francisco). Other conferences attended were the Oil Pollution Symposium (Bedford), the Canadian Symposium on Water Pollution Research (Toronto), the Offshore Technology Conference (Houston) and the Hazardous Materials Conference (San Francisco).

17) COST gave advice on oil spill countermeasures to spill co-operatives in Hamilton, Sarnia and Halifax and the Canadian Forces Staff College, Toronto.

Fisheries and Marine Service

·isheries Research and Development Directorate

GREAT LAKES BIOLIMNOLOGY LABORATORY

The Great Lakes Biolimnology Laboratory (GLBL) : CCIW conducts a research program on the relationships etween wastewater inputs, water quality and aquatic ·sources in the Great Lakes. Excess nutrient loadings, icreased primary production and altered species com-osition at all trophic levels constitute cultural eutro-hication, which continues to be examined on a regional ıd local basis using a variety of approaches. Studies hich began on a large scale in 1973 on the upper Great akes and studies on the effects of land use activities on ater quality in the Great Lakes, both guided by IJC eference Groups and the Great Lakes Water Quality oard, have required considerable participation by GLBL aff. Studies on the impact of toxic substances, waste eat and dredging activities were initiated in 1973, also ıder the terms of reference of the Canada-United States greement on Water Quality in the Great Lakes. All of ıese studies are to be continued in 1975. Field work on ake Huron, Georgian Bay and Lake Superior, as part of ıe IJC Upper Lakes Reference Study, was finished in 974, and analysis of the results will be completed in 975.

The work is composed of three main programs: Descriptive Biolimnology and Surveillance, 2) Environ-ental Toxicology, and 3) Ecosystem Metabolism Studies. he programs represent different, but complementary, pproaches to the total array of problems, with each ogram differing in its needs for subdisciplinary expertise ıd logistic support.

Coordination of activities with other components ithin CCIW is facilitated in several ways, including the CIW Management Committee and its Sub-committees .g., Assignment of Vessels Committee), the Scientific ouncil for Coordination and the Environmental Quality oordination Unit.

ESCRIPTIVE BIOLIMNOLOGY AND SURVEILLANCE

This program is based on the examination of com-unities of algae, zooplankton, zoobenthos and fish 1) to termine damage to aquatic resources and, wherever ssible, causes, 2) to establish base-line descriptions of aquatic resources to which future changes can be compared, and 3) to develop, prescribe and apply surveillance techniques on a sound statistical and economical basis.

Biolimnology of the Upper Lakes

Georgian Bay-North Channel

In 1974, a co-operative survey program was conducted on Georgian Bay and the North Channel of Lake Huron, as part of the IJC Upper Lakes Reference Study. Samples were collected on seven cruises from April to December for lake-wide estimates of chlorophyll *a* concentration, primary production, phytoplankton and zooplankton species composition and biomass.

Chlorophyll *a* concentrations, determined at approximately 75 stations, indicated seasonal cycles and a range of values similar to those found in the main body of Lake Huron in 1971.

From analytical results of zooplankton numbers and biomass calculated under contract by the University of Waterloo, numbers in the North Channel appear somewhat higher than in Georgian Bay, perhaps because of a greater "shore effect." Initial results of phytoplankton species composition and biomass analyses indicate conditions comparable to those in main Lake Huron.

Standing stocks and group composition of benthic macroinvertebrates in Georgian Bay were comparable to or higher than those found in Whitefish Bay, Lake Superior. All components, except *Pontoporeia,* tended to occur at minimum densities in the south and to increase to maximum densities in the northwest, with a large area of high standing stocks intervening in the east, adjacent to Parry Sound. Representative figures showed a total of about 2800 individuals/m^2 in the south end of Georgian Bay, increasing to about 5500 individuals/m^2 in the northwest.

Lake Superior

The analysis of samples and data collected from Lake Superior in 1973 was continued in 1974.

Surface distributions for chlorophyll *a* showed similar patterns and concentrations to those of other years. Values were generally the highest inshore, except in areas of upwelling along the north shore, and in the warmest inshore waters after July. Primary productivity rates, determined in a shipboard incubator, frequently were the highest in areas of low chlorophyll biomass and intermediate water temperatures. From these rates and values for light attenuation, it has been possible to estimate values for integrated daily production on each of the five cruises (Fig. 1) and from these, to estimate a value of 30-50 g carbon fixed/m^2/yr for annual production. This closely approximates values reported in the literature.

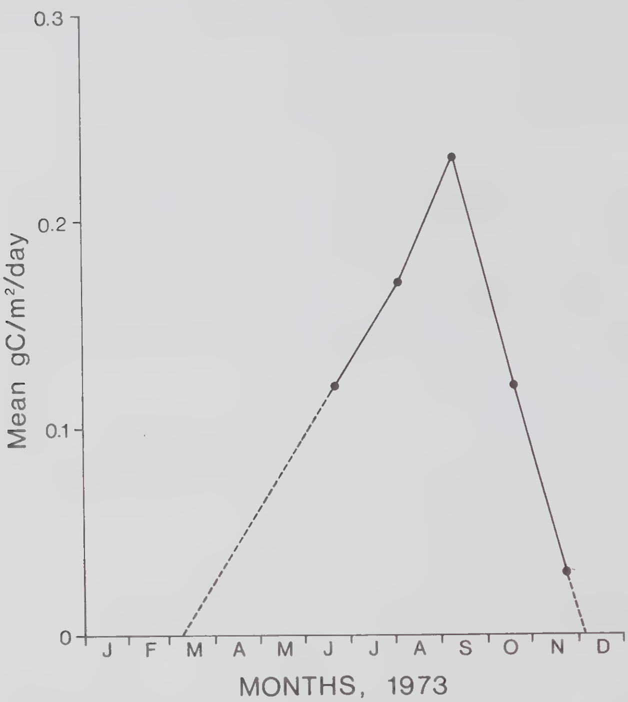


Figure 1. Seasonal pattern of primary production (^{14}C fixation) g/m^2/day for Lake Superior, 1973.

Continuing analysis of 400 benthos samples collected in 1973 indicates that previous studies have tended to overestimate benthic populations because the samples were collected in the more productive areas of the lake. Based on a uniform grid pattern of about 400 stations, our lake-wide estimate of the total macrobenthos (for May 1973) was 525 individuals/m^2. Biomass estimates emphasize the numerical dominance of *Pontoporeia* and oligochaetes, but show nematodes to be of minor importance: standing stocks (ash-free dry weight) averaged about 0.05 g/m^2 lake-wide to which oligochaetes contributed 46%; *Pontoporeia*, 38%; sphaeriids, 8%; chironomids, 5%; and nematodes only 3%.

Several major regions were recognized in Lake Superior. On the basis of total macroinvertebrate abundance, standing stocks, species diversity and taxonomic composition, the following major trends were clear:

1) benthic populations increased dramatically toward th east end of the lake. In the extreme western basin whe benthic populations averaged only 140/m^2 (0.02 g/m^2 Whitefish Bay sustained the largest populations wi 3000/m^2 (0.35 g/m^2) and
2) large benthic populations tended to occur in areas whe sediments were coarser grained, more diverse, and low in organic carbon content, relative to midlake sedimen The eastern quarter of the lake (and Whitefish Bay) we such areas, as were the Apostle Island region, the sout west shore and Keweenaw Bay (910/m^2; 0.09 g/m^2).

Estimates of numbers, species composition ar biomass of zooplankton and phytoplankton are still preparation. Initial analysis reveals that biomass is low f both groups compared to the other lakes. One importa finding is the relatively high proportion of phytoplankto biomass composed of various groups of flagellates in wh has up to now been considered a diatom-dominated lak

Comparative Studies on Great Lakes Biota

Data analysis on samples collected on Lake Ontar during IFYGL and on Lake Erie during 1970 continu at a slow pace during 1974. Cruise summaries of IFY(zooplankton data are being prepared in conjunction wi the Canadian Oceanographic Identification Centre, a papers are being written on the relationships betwe phytoplankton biomass, chlorophyll and primary prod tion from OOPS cruise data on Lake Ontario.

During 1974, GLBL received a series of zooplar ton samples collected on the lakes from 1960 to 1965 the Great Lakes Institute, University of Toronto. Hopeful these samples, when fully analyzed, will form a valua base line for the study of changes in the quality a quantity of zooplankton communities in the lakes. Stuc on the role of various size ranges of algae in prim production in the lakes have been initiated.

Surveillance of the Lower Lakes

In co-operation with several components of Environmental Management Service at CCIW, a pi surveillance program was conducted on Lake Onta during 1974. The program concentrated on data col tion to estimate the eutrophication impact on the la Initial program assessment indicates success in defir some areas where eutrophication effects (high biomass surface waters, low hypolimnion dissolved oxygen conductivities generally higher than IJC objectives) w of concern. Data analysis and evaluation continue to in the development of an ongoing long-term program the lakes.

ENVIRONMENTAL TOXICOLOGY

The general purpose of this program is the development of criteria for aquatic life 1) for toxic materials of specific concern in the Great Lakes and 2) in relation to the accumulation of hazardous materials in aquatic food chains.

Lead Toxicity

Fish

A project on lead analysis methods showed that dry-ashing and pressure digestion with perchloric and nitric acids provided the best estimates of tissue lead concentrations. Lead loss during storage of aqueous solutions of lead was minimized by acidifying the samples. Unacidified samples lost 50% of total lead within one day and more than 90% after 32 days.

The nominal 96-hour LC50 of lead nitrate for guppies (*Poecelia reticulata*) ranged from 180 mg Pb/l (no mortality) to 240 mg Pb/l (100% mortality). The formation of a white precipitate caused a marked pH drop at or above 240 mg Pb/l. The drop was associated with an increase in dissolved lead from 1-5 mg/l (nominal lead concentration = 180 mg/1) at pH's greater than 6 to more than 40 mg/l (nominal = 240 mg/l) at pH's less than 6. It appeared that the buffering capacity of the test water was exceeded from 180 mg Pb/l to 240 mg Pb/l and the lower pH's promoted toxicity by increasing the solubility of lead.

Invertebrates

Preliminary 96-hour LC50 experiments have been completed using $PbCl_2$ as the toxicant on *Lymnaea palustris* and *Orconectes immunis* in distilled water and aquarium-conditioned water. The values are approximately: *Lymnaea palustris* – 0.1 ppm $PbCl_2$ in distilled water and 10 ppm in aquarium water; *Orconectes immunis* – 0.1 ppm in distilled water and >10 ppm in aquarium water.

Total lead in the soft parts and shell of natural populations of *Lymnaea stagnalis* was found to be 0.944 ppm Pb in shell and 0.159 ppm Pb in body. These results will be correlated with weight of various tissues and shell and compared with laboratory-bred and other natural populations of *Lymnaea*.

White light responses and threshold limits of *Hyalella azteca* have been completed. Threshold appeared at 1.4 lux. Effects of $PbCl_2$ and $CdCl_2$ on light responses are being determined.

Algae

The toxicity of Pb on algae, as demonstrated by decreasing primary productivity and cell growth, depends on a number of factors including

1) incubation medium: Pb was more toxic to *Ankistrodesmus falcatus* and *Scenedesmus quadricauda* in filtered, sterile lake water than in a synthetic CHU-10 medium. It was also more toxic in a soft water (low carbonate) than in a hard water,
2) temperature: the lower the incubation temperature, the lesser the Pb toxicity. At 9°C, the toxicity was only 15% of that at 20°C,
3) chemical species: in general, organoleads were more toxic than inorganoleads, and
4) algal species: *Scenedesmus quadricauda* was more resistant to Pb than *Ankistrodesmus falcatus.*

Methylation of Lead

(in collaboration with Dr. Y.K. Chau, Lakes Research Division)

Sediment samples from Hamilton Harbour, Lake St. Clair and several lakes around Sudbury were found to contain micro-organisms capable of methylating several non-volatile leads into a volatile tetramethyl lead (Me_4Pb). Under optimal conditions, the maximum rate for the conversion was 6% in one week. Pure species of bacterial isolates from Lake Ontario were able to transform trimethyl lead acetate, but not inorganic leads, into Me_4Pb in chemically defined media and in the absence of sediment.

The primary productivity and cell growth of *Scenedesmus quadricauda* were found to decrease by 85% and 32%, respectively, when the alga was exposed to less than 0.5 mg Me_4Pb/l.

Me_4Pb was much more toxic to algae than other lead compounds.

Cadmium Toxicity

Cadmium appears to be more toxic to algae than lead. At levels as low as 25-250 μg Cd/l, the primary productivity of *Ankistrodesmus falcatus* was reduced by 17-20% of the control. At 500 μg Cd/l, the reduction was 50%. *Chlorella pyrenoidosa* was even more susceptible to Cd. At Cd concentrations from 25-1000 μg/l, the productivity decreased by 27-91% of the control. The alkaline phosphatase production in algae was a more sensitive indicator for the Cd toxicity than the primary productivity. At concentrations as low as 50 μg Cd/l, the enzyme production was reduced by over 40% of the control.

Fractionation of Sulphur Isotopes by Algae

(in collaboration with Dr. J.O. Nriagu, Lakes Research Division)

The biofractionation of sulphur isotopes is significant to the understanding of the biogeochemical cycling of sulphur in ecosystems, a question of considerable concern in view of the effects of sulphur pollution on environmental quality.

Chlorella grown in a large pool of sulphate could accumulate considerably more sulphur than was required for growth. The metabolic sulphate uptake was accompanied by preferential removal of the lighter ^{32}S isotope. The isotope fractionation factor between the cells and the medium was constant (6 ‰) and much larger than was generally believed. Selective transport of ^{32}S across the cell membrane was believed to be responsible for the observed isotopic effects.

Identification of Hazardous Polluting Substances in the Lower Great Lakes

This study, undertaken by James F. MacLaren Ltd., was presented in two volumes; Volume A details the results, conclusions and recommendations of the study and Volume B tabulates all of the supporting data.

A list of 1200 hazardous materials, in descending order of potential danger to the aquatic environment, has been developed according to the criteria of toxicity to aquatic life, amounts used in commerce and industry, and mode of transport and storage.

This project, pertinent to Task 11, Canada-United States Water Quality Agreement, was carried out in co-operation with the Environmental Protection Service to support possible measures to prevent or minimize damage to aquatic resources through accidental discharge of hazardous materials.

Pollution from Land Use Activities Reference

The designated activity of GLBL in the Reference Group's study plan is to employ lake-column simulators in the laboratory to test the effects and potential for biomagnification of contaminants detected in agricultural land runoff by other groups. This information will guide MOE biologists in field investigations of potentially adverse effects of pest control products. In 1974, the simulators were installed and preliminary experiments with varied nutrient loading rates, additions of algae and physical mixing were carried out to aid in the development of community characteristics most useful for the testing of contaminants in experimental additions in 1975-77.

ECOSYSTEM METABOLISM STUDIES

The general objective of this program is to elucidat temporal and spatial relationships in the freshwater flor and fauna and their disruption in mixing zones caused b additions of both thermal and toxic effluents, nutrients and dredged spoils.

Waste Heat Studies

Studies on thermal discharges at the Nanticok Generating Station on Lake Erie commenced at th beginning of April. In co-operation with the Electroni Engineering Section, CCIW, the acoustic fish census sys tem used in 1973 was upgraded and further tested wit mid-water trawls and artificial targets to determine th effects of discharges to the Great Lakes on fish abun dance and distribution. In addition, temperature-sensin ultrasonic transmitters were attached to yellow perch common white sucker and rock bass enabling their beha viour in various thermal regimes to be monitored (Fig. 2)

Figure 2. Monitoring the movement and behaviour of ultrasonic "tagged" fish in relation to the thermal discharge at Nanticoke Generating Station.

Net uptake of ^{14}C by phytoplankton samples co lected from the discharge was 60-80% lower than tho collected from the intake, but there was no obviou relationship to temperature increase. Chlorophyll levels c an average were only slightly lower in discharge sample Filtering rates of zooplankters measured before and aft passage through the condensers revealed that most of t animals survived the experience, but some species a peared to recover faster than others. In contrast, larv fish suffered 100% mortality. Compared with contr samples, fragmentation of *Cladophora*, grown on artifici

ubstrates in areas influenced by the discharge water, ccurred earlier only in the discharge canal.

Studies will be continued at a new thermal generting station site in 1975-76 and will be extended to nclude complementary laboratory investigations.

aper-Mill Plume Studies

Many of the techniques used in the waste heat tudies were employed at Red Rock on Nipigon Bay, ake Superior, from mid-July to mid-August in 1974. CIW research personnel from the Scientific Operations nd Lakes Research Divisions were also on site collecting ata on water chemistry and microbiological activity. The ulp and paper mill effluent plume was injected with a ed dye and tracked by an aircraft in radio contact vith a small boat. Drogues were also used with limited uccess to follow the plume over time and space. Performnce indices of the biota showed that the plume had a eleterious effect on all trophic levels in the near-shore rea.

roject Quinte

Co-operative research (with the Ontario Ministries of latural Resources and the Environment) on the Bay of luinte was continued to determine the response of biota o the federal-provincial nutrient removal program iniated in 1973. GLBL, OMNR and MOE staff worked on utrient budgets, primary production, zooplankton, bennic macroinvertebrate communities and general limnology f the Bay of Quinte. GLBL involvement in the Bay of luinte program will be increased in 1975 in preparation or a major program including a waste heat study at the ennox Generating Station in 1976.

poil Disposal from Dredging Operations

Studies on the effects of dredged spoil disposal were nitiated in 1973 in a co-operative study with the Ontario linistry of Natural Resources and other groups, under ne terms of reference of the Canada-United States Water luality Agreement (Task 8). The work in Lake Erie (Port tanley) included

1) phytoplankton and zooplankton bioassays of serial dilutions and ambient water during spoils disposal,
2) examination of benthic macroinvertebrate communities before, during and after spoil disposal, and
3) evaluation of the usefulness of electrical acoustic fish census techniques to determine the response of fish to spoil disposal events.

The latter technique provides a means of examining the pattern of solids sedimentation in time and space in relation to specific disposal events and will be extremely valuable in future work on fish. Similar bioassays of spoils and collections of benthic macroinvertebrate communities were also conducted at the pilot-scale artificial island in Lake St. Clair during 1974. This work will be continued in 1975 with a large effort directed toward a laboratory study employing 4.5-metre vertical lake-column simulators, which will be loaded at various rates with a variety of dredged materials.

Joint Projects with Universities

During 1974, GLBL staff co-operated with universities by supervision of FRD grants, development of contracts and supervision of graduate students. Those involved included Dr. G.M. Sprules, Biology Department, Erindale College, University of Toronto — zooplankton community structure in Ontario lakes (FRD Grant); Dr. J. Carter, Biology Department, University of Waterloo — zooplankton identification and enumeration, Georgian Bay (contract); Dr. J.M. Bristow and Miss A. Crowder, Biology Department, Queen's University — a study of aquatic macrophytes in the Bay of Quinte (FRD Grant); Dr. J.B. Sprague, Zoology Department, University of Guelph — Bay of Quinte studies (contract); Mr. E.E. Pickett, Mr. R. Sheath, University of Toronto; Mr. B. Drimmie, Dr. C. Mayfield and Mr. Tom Pickering, University of Waterloo; Mr. Scott Millard, Mr. K. Young, University of Guelph (graduate student direction and assistance).

Algology courses were presented at the Queen's University Biological Station (summer course) and at Scarborough College, University of Toronto. Staff also participated in a speleological expedition sponsored by Northwestern University, Evanston, Illinois, involving the systematics, zoogeography and ecology of oligochaetes.

This contribution to the CCIW Annual Report
by the Great Lakes Biolimnology Laboratory
is dedicated to

Dr. David G.S. Wright

who joined GLBL on October 10, 1973, following graduate studies at the University of Guelph and a post-doctoral fellowship at the University of British Columbia. Dr. Wright had developed invertebrate cultures and light-bench equipment and was conducting studies on the chronic effects of toxicants on photo-responses at the time of his death on October 26, 1974.

Marine Sciences Directorate, Central Region, Ocean and Aquatic Affairs

OVERVIEW

Marine Sciences, Central Region, is part of the Fisheries and Marine Service and reports directly to the Assistant Deputy Minister of Ocean and Aquatic Affairs. It consists of four Divisions: Hydrographic, Research and Development, Ships, and Administration. The Hydrographic Division collects, processes and compiles data for the construction and maintenance of navigation and resource charts, the production of nautical publications, and the support of engineering projects. The Research and Development Division collects, processes and analyzes physical oceanographic and coastal morphological data for engineering programs, marine transportation and the assessment and prevention of environmental degradation. Launch and ship support is provided and maintained by the Ship Division for Marine Sciences and Great Lakes Biolimnology Laboratory activities, and as well for EMS and EPS. Administrative, financial and material management along with personnel interface are provided by the Administration Division.

Marine Sciences, Central Region, operates within the approximate geographical boundaries of the Manitoba-Saskatchewan border in the West to Father Point on the St. Lawrence River in the East. In the North, Regional activities cover Hudson and James Bays and extend into the Arctic Islands. Within these areas, three main political issues can be identified within the scope of Marine Sciences' mandate in Ocean and Aquatic Affairs.

Exploitation of Non-renewable Resources

Extensive hydrocarbon drilling has taken place from ice platforms in the Arctic Archipelago, from artificial islands in the Beaufort Sea and from conventional platforms in Hudson Bay. Various pipeline routes have been proposed to transport the gas to the industrial centres of the South, but recent studies have indicated that our knowledge of Arctic waters is insufficient for the effective and safe extraction of the hydrocarbon and mineral resources of this area. Thus increased program activity in hydrography and oceanography is essential in these remote and data-deficient areas.

Protection of the Environment

In Hudson Bay and around the eastern Arctic Islands, there is still time to carry out bathymetric and oceanographic surveys to reduce the risk of navigational hazard and to assess the effect of potential disasters. In the South, the extensive dredging operation in the St. Lawrence River downstream from Quebec will be completed in 1976, enabling 100,000-ton tankers to reach Quebec and extensively altering the morphological and oceanographic regime of the river. High water levels on the Great Lakes and consequent shoreland erosion and inundation necessitate increased activity, involving both the federal and provincial governments in the development of more effective coastal zone management. To ensure continued safe and efficient navigation of the Great Lakes, increased bathymetric and revisory surveys are mandatory.

Management of Renewable Resources

The native fisheries in James Bay, particularly the anadromous fish, must be protected when river modifications for the hydro power development disturb the present ecological balance in the river estuaries, increasing the need for physical and biological (FRD) site-specific studies.

HYDROGRAPHIC DIVISION

AIMS AND ORGANIZATION

The work of the Central Region Hydrographic Division is primarily the collection and preliminary processing of hydrographic data. In addition, some attention is given to providing navigational assistance and advice to other groups working at CCIW.

The hydrographic operations involve three main geographic programs and are supported by three types of technical support. The three geographic programs are

1) Surveys of the St. Lawrence River and Great Lakes system for commercial navigation,

2) Surveys of inland lakes and waterways to produce charts and publication for recreational boating, and

3) Surveys of Arctic waters for navigation and resource development.

In the first of these areas, much of the original survey work has been completed, although there remain extensive areas where soundings were collected by leadline. The emphasis is placed on maintaining the charts by re-surveys and revisory surveys.

In the second area, the burgeoning population of central Canada, in particular Ontario, has more and more leisure time. Recreational boating is very popular, and surveys are needed to produce special charts and publications to meet public needs.

In the third area, the search for hydrocarbons and the use of better vessels are opening the Arctic to commercial navigation. The survey program must be accelerated to provide safe navigation and to map the undersea resources.

Associated with the hydrographic surveys is the provision of information on tides, tidal currents and water levels. A small Cartographic Unit provides a graphic capability and a strong Technical Development group ensures that the surveys are provided with equipment and software that assist in efficient operations.

REVIEW OF SURVEY PROJECTS

In the *St. Lawrence River*, a large survey unit worked ut of Montmagny, surveying the channels in the vicinity of le aux Oies and Crane Island. Later in the season, a survey f the Chenal de l'Île-d'Orléans was conducted under ontract. These surveys of the lower St. Lawrence River vere started in 1969 and are aimed at providing new charts rom the Saguenay River to Quebec by 1976. This will oincide with completion of the deep dredging of the North raverse, southeast of Île d'Orléans (Fig. 3).

In the *Great Lakes*, work was carried out in conjunction with inshore surficial geology studies along the orth shore of Lake Erie in the general vicinity of Point elee. In Lake Huron, a new program was started to survey he offshore bathymetry to improve our knowledge of hese large basins (Fig. 4). This survey used the high-speed utter ADVENT, which proved successful. It also employed he HAAPS (Hydrographic Acquisition and Processing ystem) (Figs. 5 & 6). Locally, a survey of Frenchman Bay ear Toronto was completed. A survey of Toronto Harbour as commenced.

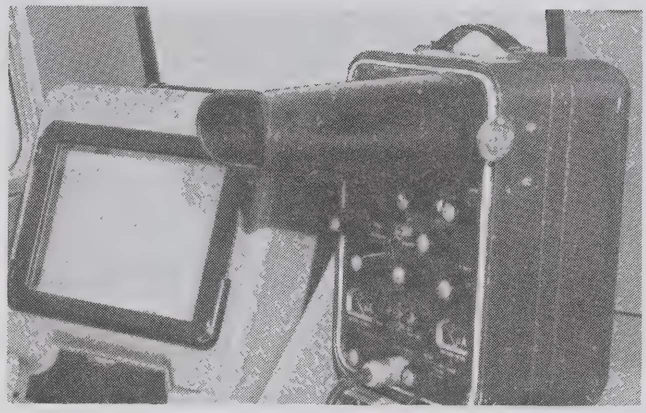


Figure 3. MRB 2 Hydrodist and Raytheon echo sounder used in the St. Lawrence River Survey.

Figure 4. MRB 2 Hydrodist shore station used in range-bearing mode on Lake Huron.

Figure 5. The HAAPS processing system.

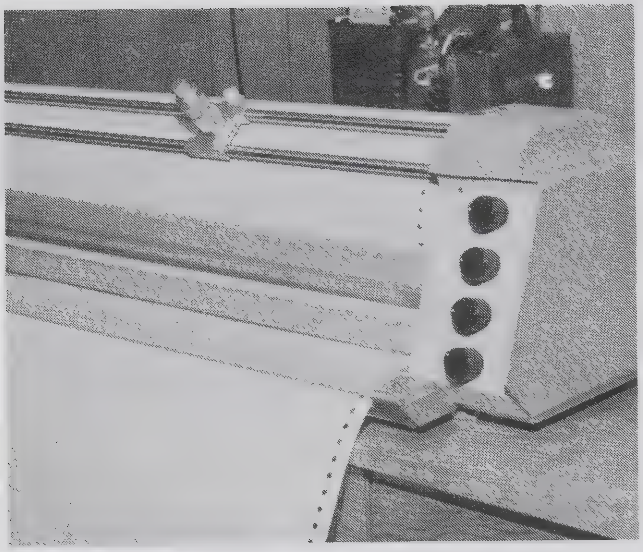


Figure 6. CALCOMP plotter for HAAPS.

The program of chart revision has now been arranged in a cyclic system. Every second year, charts of those parts of a lake that undergo frequent change are revised, and every fourth year the charts of areas that are less changeable are revised. The large survey launches VEDETTE and VERITY worked on Lake Superior and the lower St. Lawrence River, respectively (Fig. 7).

The program in *Lake Winnipeg* was in its second year. This operation has two components. The northern half of the lake itself is being surveyed, and the harbours are being surveyed separately. The offshore surveys had a faltering start with many problems involving chartering ships, instrumentation and launch failures. Matters improved greatly toward the end of the season, and the chartered vessel LADY CANADIAN equipped with the latest automated equipment measured many productive survey miles. The harbours of Hecla, Gull Harbour, Manigotagan and Gimli were completed.

A very active program was maintained in the *Arctic*. Hydrographers, working with the Polar Continental Shelf Project and using helicopters and through-the-ice sounding methods, surveyed almost the entire fjord system of Eureka Sound and Nansen Sound. This operation was marred only by a helicopter accident near the conclusion, which was not fatal.

In Hudson Bay, a survey was completed of *Chesterfield Inlet* from the sea to Baker Lake (Fig. 8). This remarkable achievement resulted in NARWHAL reaching the settlement at Baker Lake, the largest ship to make this passage to date. NARWHAL, provided by the Ministry of Transport, was an ideal base as a mother ship for two large launches and later as an oceanographic platform in James Bay (Fig. 9).

Table 1 summarizes the Survey programs and some of the significant equipment used.

TIDES, CURRENTS AND WATER LEVELS

The year marked a major increase in tidal affairs. The responsibility for tidal matters concerning navigation was

Table 1. Survey Programs in 1974

Survey area	Vessel	Positioning system	Field data processing
Lower St. Lawrence	2 x 35 ft 4 Botved (22 ft)	Miniranger, Hydrodist	HAAPS (part-time)
Lake Erie	Bertram (25 ft)	RPS, Miniranger	manual
Lake Huron	ADVENT (77 ft) BRUCE (31 ft) VEDETTE (48 ft)	Minifix	HAAPS
Toronto Harbour	1 Botved (22 ft)	Hydrodist	manual
Thunder Bay	Contract		
Lake Winnipeg offshore	4 Hydros (25 ft) LADY CANADIAN	Minifix	INDAPS
Lake Winnipeg harbours	3 x 20-25 ft	Hydrodist	manual
Polar Shelf	3 x 206 helicopters	RPS	manual
Chesterfield Inlet	2 x 35 ft 1 x 20 ft	Miniranger	HAAPS
Revisory–St. Lawrence	VERITY	Hydrodist	manual
Revisory–Superior	VEDETTE	Hydrodist	manual

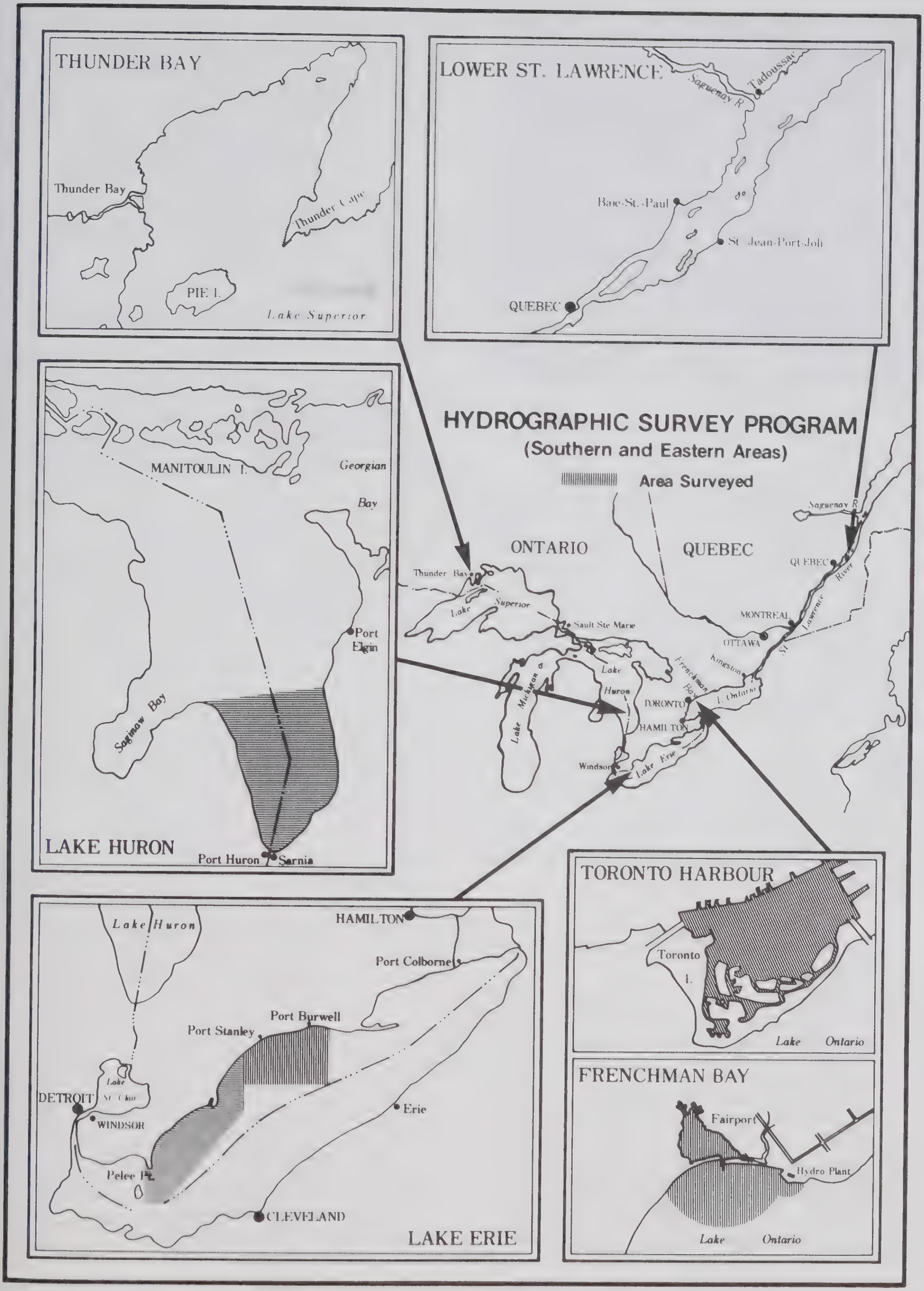


Figure 7. Central Region 1974 Hydrographic Survey Program (southern and eastern areas).

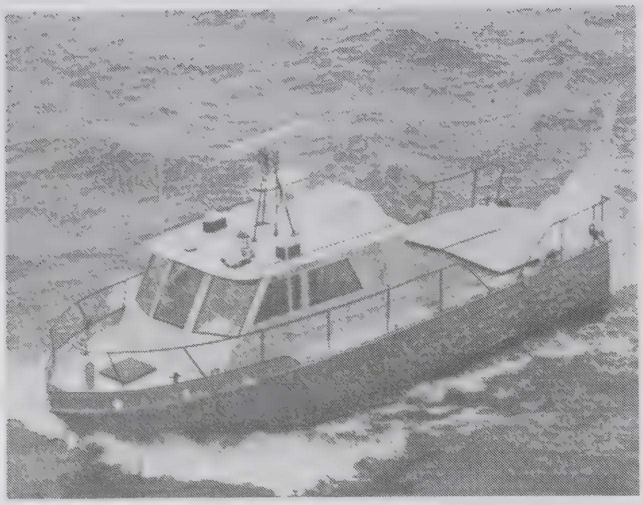


Figure 8. Survey launch STURDY used in Chesterfield Inlet.

returned to the Hydrographic Division. At the same time, a Tidal Instrument Development group was transferred to the Region from Headquarters. The new tidal support group has been established with three men. Their responsibility will be to provide advice and assistance to the hydrographic survey parties on location of gauges, preparation of co-tidal charts, datums and the analysis of data. The monthly and weekly water level bulletins for the Great Lakes have been redesigned and are now produced by this group. Assistance was provided in running a current survey in the St. Lawrence using the BAYFIELD.

The Tidal Instrument group has undergone the administrative turmoil of re-establishing itself. Work has continued on a system to retransmit data via satellite. Responsibility for monitoring a major contract to maintain the permanent gauge telemetering network has been transferred to this group (Fig. 10).

SIGNIFICANT DEVELOPMENT PROJECTS

The Regional Office continues to promote an active program of technical development. Two major projects have been the development of a new automatic data collection and processing system, designated INDAPS (Integrated Navigation, Data Acquisition and Processing System) and the evaluation of a Magnavox Satellite Doppler Sonar Integrated Navigation System. The INDAPS development has had the remarkable record of being designed, built and in productive use within the year. It is, in fact, an improved design of the HAAPS (Hydrographic Acquisition and Processing System). The Satellite Doppler Sonar System promises to provide navigation of a high order of accuracy for research ships on the Great Lakes, but to date has not reached its specifications.

The GERBER 22 plotter has again been used extensively in the preparation of the final field sheets. The sidescan sonar has been employed in several areas, but has had considerable electronic trouble.

STAFF EXCHANGE PROGRAM

Once again, staff have been exchanged with the National Ocean Survey to encourage the sharing of ideas and technical information.

HYDROGRAPHIC CONFERENCE

The Annual Hydrographic Conference was sponsored by the Central Region Canadian Hydrographic Service and the Canadian Hydrographers' Association this year. The Conference, held in March, attracted a large delegation of American hydrographers and several European hydrographers.

CARTOGRAPHIC UNIT

In April 1974, Marine Sciences, Central Region, assumed the responsibility of producing the Great Lakes Monthly Water Level Bulletins. The Cartographic Unit at that time purchased the equipment necessary for in-house photo-mechanical reproduction. This facility enables the Unit to have all reproduction material ready for the printer's press within 24 hours of receipt of the water level data. Generally, the Unit was able to lessen its dependability on commercial photographic services, saving time and expenditure.

Some major projects during 1974 were the design and preparation of programs, tickets, etc., for the 1974 Canadian Hydrographic Conference; the design of new covers for CHS reports; the design and preparation of multicoloured illustrations for the Great Lakes Shore Damage Interim Report; and the design and preparation of charts and graphics for the 1975 Toronto Boat Show.

PLANS FOR 1975

The *Lower St. Lawrence River Survey* is to be completed. In the *Great Lakes*, hydrographers will continue to work with the geologists in the western end of Lake Erie. The bathymetric survey of Lake Huron will be continued. Revisory Surveys will be made in Georgian Bay, Lake Ontario and the upper St. Lawrence River. The Survey of Toronto Harbour will be completed.

Surveys in *Lake Winnipeg* will continue. The completion of the harbour surveys is planned, but the offshore

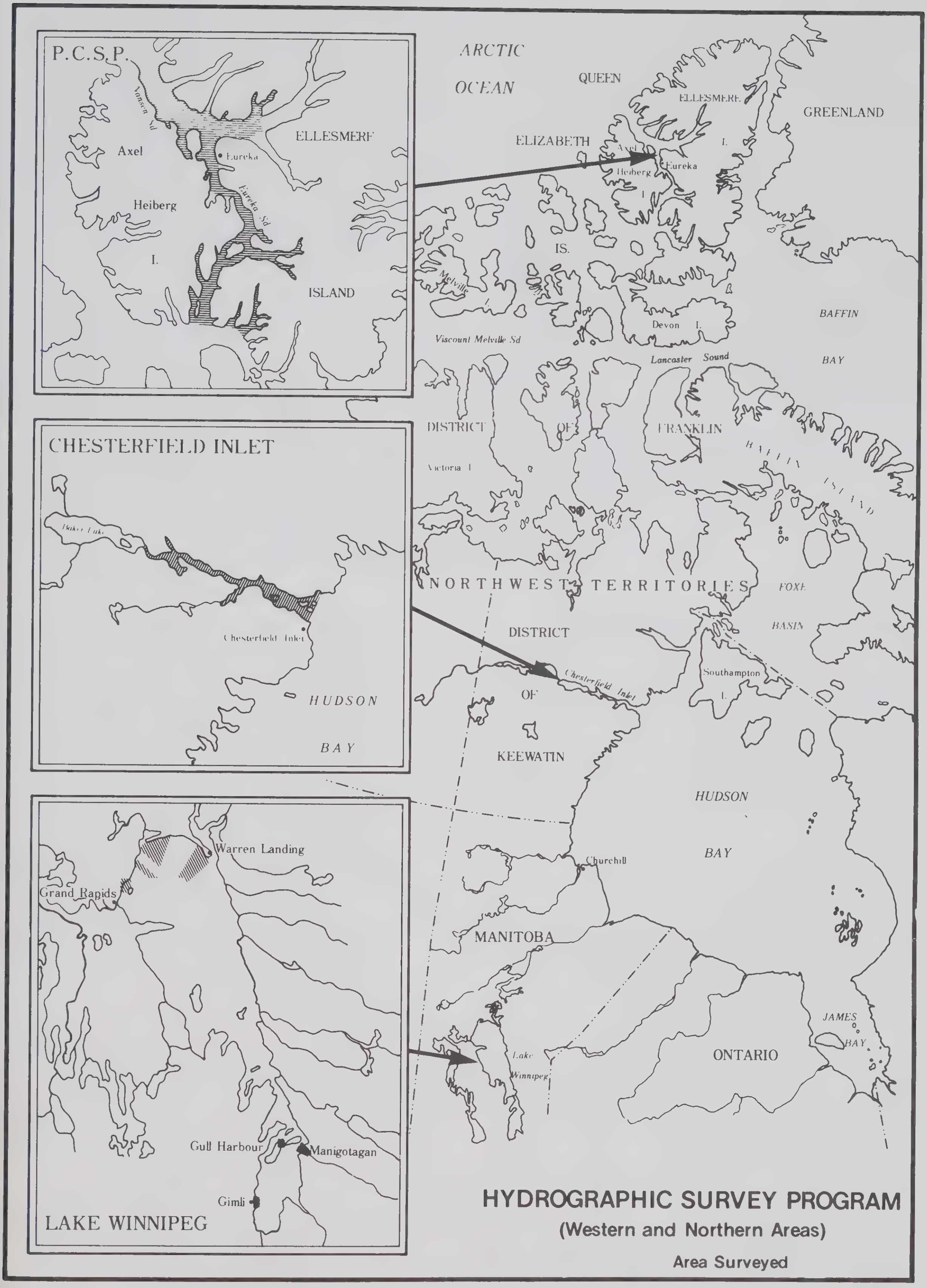


Figure 9. Central Region 1974 Hydrographic Survey Program (western and northern areas).

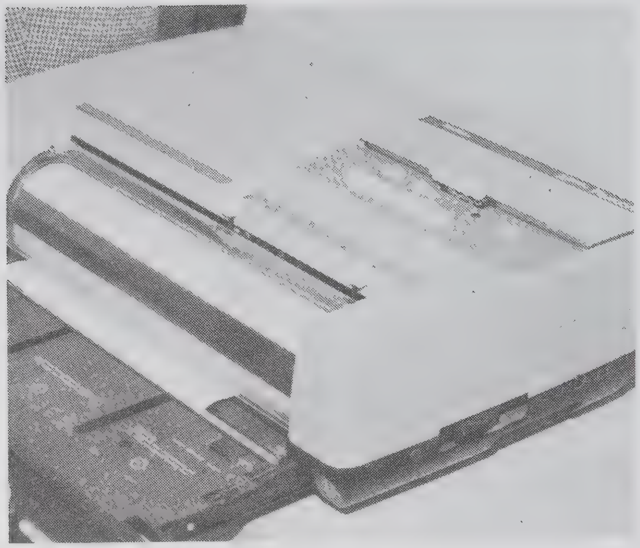


Figure 10. Telecopier used for communicating tidal data for the Lower St. Lawrence Survey.

area will require several more years.

In the *Arctic*, hydrographers will be working on th Polar Continental Shelf Project in *Nares Strait*. The mos important new project will be a major offshore bathy metric-geophysical survey of *Hudson Bay*. Associated wit that survey will be a shore-based survey at Povungnituk Another new project will be initiated in James Bay in th spring. In collaboration with the Dominion Observatory, two-year through-the-ice survey is planned for the area.

Some important plans exist for improvements i survey technology. The Satnav/Doppler System is to b used for navigation on the Hudson Bay multi-paramete survey. Based on the success of the INDAPS, both the Lak Huron and Lake Winnipeg Surveys are to be provided wit that equipment. The HAAPS will be employed in th St. Lawrence River Surveys.

RESEARCH AND DEVELOPMENT DIVISION

The Division's major goal in the past year and over the next few years is to develop an oceanographic research competence, particularly in physical and chemical oceanography, for the study of processes in the James Bay-Hudson Bay system. As a result of a meeting held on January 14, 1975, with the ADM and the corporate management of Ocean and Aquatic Affairs, the Director, Central Region, was officially given jurisdiction over the Hudson Bay-James Bay system for oceanographic studies, in addition to the previously obtained jurisdiction for hydrographic surveys. Also, the Division was involved in a number of multi-service and multi-agency programs, particularly the St. Clair River Current Study, commonly called "Operation Preparedness," with EPS; the federal-provincial agreement for a Shore Damage Survey with EMS and OMNR; and the storm surge prediction work with EMS and AES.

The programs in 1974 (Fig. 11) were carried out by the four Sections—Hydrodynamics, Shore Property Studies, Oceanographic Research, and Survey Electronics, with the following objectives:

1) to provide information on current predictability and spatiality in the St. Clair-Detroit Rivers for "Operation Preparedness,"
2) to give a descriptive and predictive capability for the tides and currents in the upper St. Lawrence River estuary,
3) to provide a marine and estuarine environmenta impact assessment of the James Bay Powe Project,
4) to use the results of the Canada-Ontario Grea Lakes Shore Damage Survey for developing mor efficient coastal zone management and plannin policies,
5) to investigate the feasibility of photogrammetri methods in erosion rate monitoring,
6) to provide survey electronics support to the hydro graphic and limnological field programs, and
7) to establish increased instrument developmen capability in hydrodynamics and physica oceanography.

New programs areas for 1975 include

1) a physical oceanographic study in Hudson Bay,
2) the formation of an Environmental Assessme Section to support the James Bay Impact Stat ment and for representation on the Screeni and Coordinating Committee of the Enviro mental Assessment and Review Process,
3) a hydrodynamics study in connection with t Gulf of St. Lawrence Program, and
4) the establishment of long-term shore protecti sites on the lower Great Lakes.

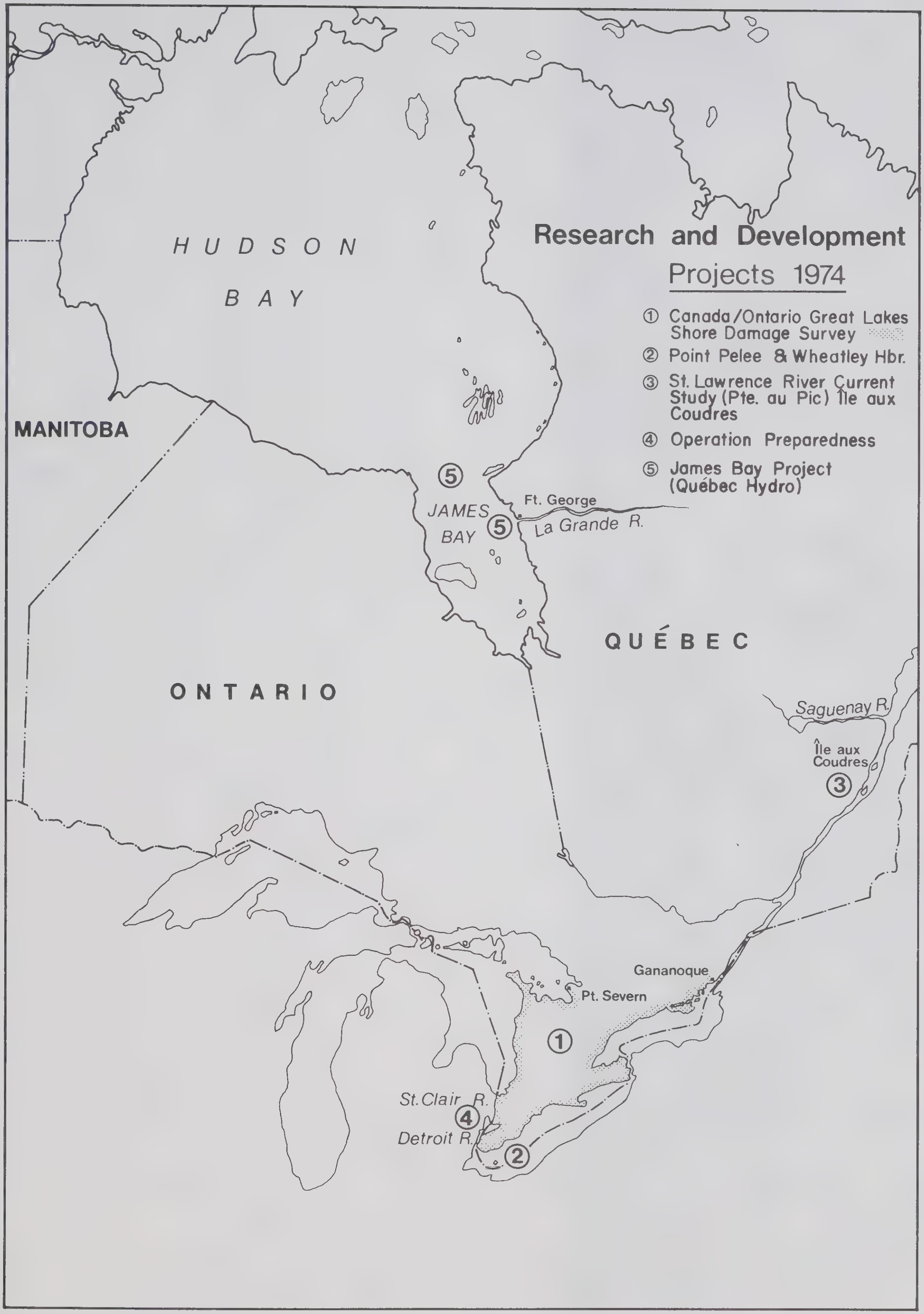
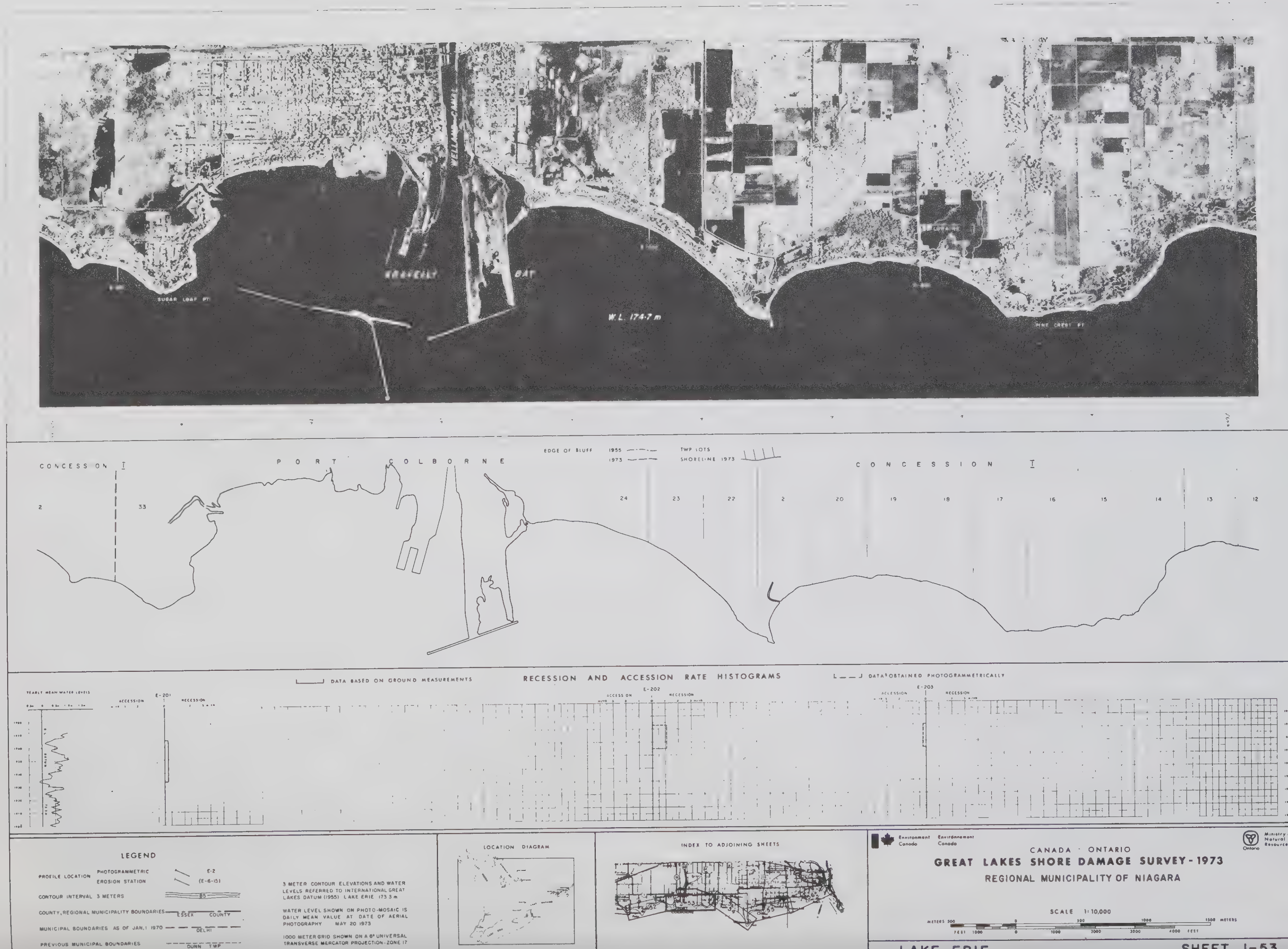


Figure 11. Research and Development Division projects for 1974.



SUGAR LOAF PT
BAY
W.L. 174·7 m
PINE CREST PT
CONCESSION I
PORT COLBORNE
CONCESSION I
EDGE OF BLUFF 1955 1973
TWP LOTS
SHORELINE 1973
2
33
24
23
22
2
20
19
18
17
16
15
14
13
12
RECESSION AND ACCESSION RATE HISTOGRAMS
DATA BASED ON GROUND MEASUREMENTS
DATA OBTAINED PHOTOGRAMMETRICALLY
YEARLY MEAN WATER LEVELS
E-201
E-202
E-203
ACCESSION
RECESSION
LEGEND
PROFILE LOCATION
PHOTOGRAMMETRIC
EROSION STATION
E-2
(E-6-15)
CONTOUR INTERVAL 5 METERS
COUNTY, REGIONAL MUNICIPALITY BOUNDARIES
ESSEX
COUNTY
MUNICIPAL BOUNDARIES AS OF JAN. 1 1970
DELHI
PREVIOUS MUNICIPAL BOUNDARIES
DUNN TWP
5 METER CONTOUR ELEVATIONS AND WATER LEVELS REFERRED TO INTERNATIONAL GREAT LAKES DATUM (1955) LAKE ERIE 173.3 m
WATER LEVEL SHOWN ON PHOTO-MOSAIC IS DAILY MEAN VALUE AT DATE OF AERIAL PHOTOGRAPHY MAY 20 1973
1000 METER GRID SHOWN ON A 6° UNIVERSAL TRANSVERSE MERCATOR PROJECTION - ZONE 17
LOCATION DIAGRAM
INDEX TO ADJOINING SHEETS
Environment Canada
Environnement Canada
Ministry of Natural Resources
Ontario
CANADA · ONTARIO
GREAT LAKES SHORE DAMAGE SURVEY - 1973
REGIONAL MUNICIPALITY OF NIAGARA
SCALE 1:10,000
METERS
FEET
LAKE ERIE
SHEET I-53

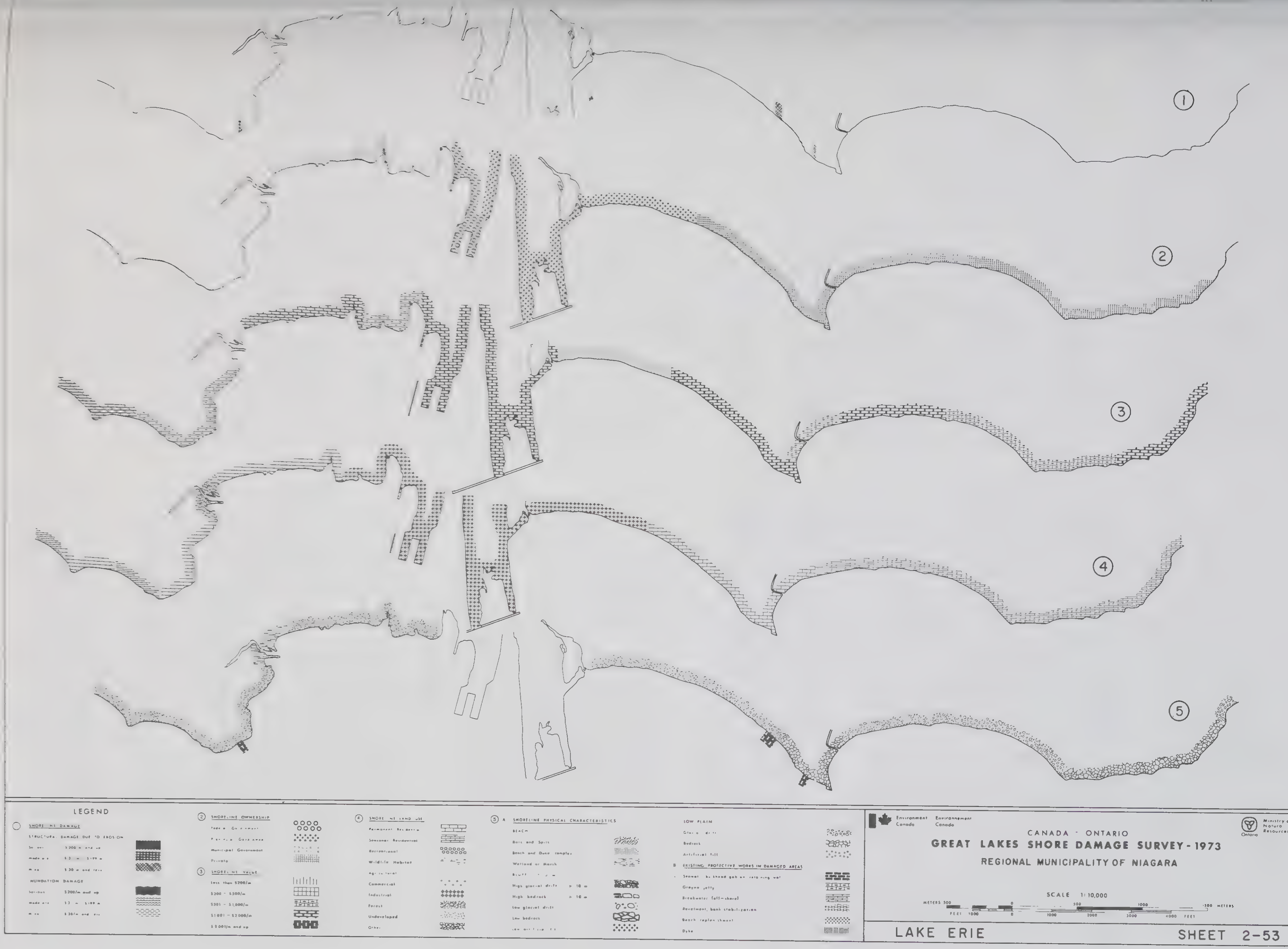


Figure 13. Coastal Zone Atlas – map sheet no. 2.

CANADA-ONTARIO GREAT LAKES SHORE DAMAGE SURVEY

Under the project management of the Shore Property Studies Section, the field surveys of this federal-provincial agreement were brought to a successful conclusion in 1973, while the collection of riparian property assessment data continued until April 1974. The rest of 1974 was used to analyze data and develop recommendations in conjunction with the Social Sciences and Water Planning and Management Sections of IWD. In October, an Interim Report was produced and forwarded to the respective ministers of Environment Canada and the Ontario Ministry of Natural Resources. The report contains the results of the survey and a number of recommendations concerning shoreline management, planning and protection. By the end of the year, follow-up programs were being developed to examine the coastal zone management alternatives.

Monitoring of the erosion stations established in 1972 continued in 1974, providing erosion coverage during the high water periods from 1972 to 1974. Updating of the oblique-angle aerial photography was undertaken in 1974, involving sequential coverage from Port Severn to Sarnia on Lake Huron and from Niagara-on-the-Lake on Lake Ontario to Trois-Rivières on the St. Lawrence River.

The technical report of the Canada-Ontario agreement is presently being finalized and will be ready for distribution early in 1975. The Coastal Zone Atlas, which will depict various shoreline parameters such as land use, ownership, value and physical characteristics as well as histograms of recession or accession rates, is nearing completion and should be ready within the same time frame as the technical report (Figs. 12 & 13).

WHEATLEY HARBOUR

The Shore Property Studies Section carried out a research program in Wheatley Harbour during 1974. With the co-operation of the Department of Public Works, sand material dredged from the approaches to the harbour was scow-placed at a point 4 km southwest of Wheatley. The material was put at an approximate 3-metre depth in the zone of long-shore transport. Profiles taken at the dumping site and in the Point Pelee area will indicate the feasibility of nourishing beaches in this area by stockpiling.

TASK D LAND DRAINAGE REFERENCE GROUP (GLWQB–IJC)

The Shore Property Studies Section represented the Division on this task force by participating at meetings and by contributing material on shore erosion and land fill. The Reference Group is seeking to determine the degre of pollution from land-based sources, and our interes is that portion attributable to shore erosion and th related dispersion of materials. Inputs related to land fill ar aimed at establishing the feasibility of stabilizing shoreline with artificial fill, through its effects on natural shorelin processes.

PHOTOGRAMMETRIC BLUFF SURVEYING –LAVAL UNIVERSITY

The Shore Property Studies Section established a contract with Laval University, Quebec, which investigated the feasibility of measuring erosion and accession by photogrammetric methods. The purpose of the evaluation was to compare this method with the classical ground surveying methods presently used. The results of the comparison showed that photogrammetric surveying could prove economically preferable in the long run, but tha classical ground surveying methods should be continued where ground control has been established.

POINT PELEE EROSION SURVEY, 1974

To determine the extent to which the commercia dredging activities and existing protection in the area hav affected beach erosion within the National Park, over an above the erosion that can be expected from natural causes a joint study was undertaken by the Department of Indian & Northern Affairs (Parks Canada Directorate) and Environ ment Canada. In conjunction with the Lakes Researc Division, the Shore Property Studies Section established a network of profile stations around the Point and surveye them on a continuous basis during the months of May an June and September and October (Fig. 14).

Profiling consisted of an onshore survey using conver tional topographic methods, while the offshore sector wa attained through hydrographic procedures. Changes in th near-shore zone were recorded by extending the onshor profile beyond the waters edge to a depth of approximatel 1.5 metres. To supplement the sequential profile data, current analysis was undertaken to determine sedimer transport. Drogues were used during the May-June phase c the study, while two self-recording E.M. current meter were installed by the Mechanical Engineering Unit c CCIW for the September-October phase.

JAMES BAY OCEANOGRAPHIC STUDIES

The main objectives of the Oceanographic Researc Section's program in James Bay include

1) the determination of the present distribution of salinity, temperature and dissolved oxygen in the estuaries and the Bay, including the seasonal distribution and

2) the examination of the physical processes contributing to these distributions.

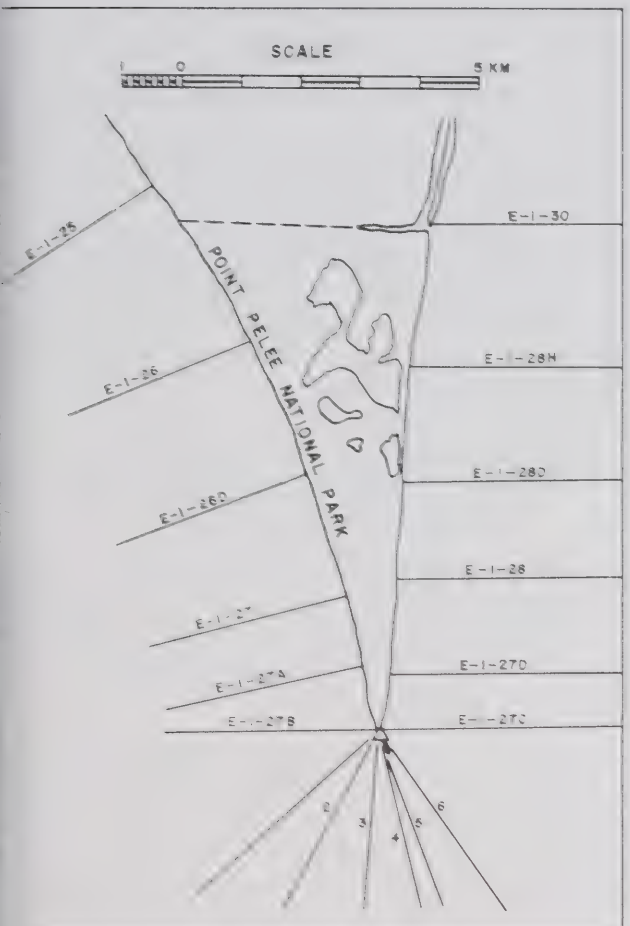


Figure 14. Point Pelee Erosion Survey profile locations.

These studies must be completed and understood to ovide the specific information on which an assessment of e possible effects of the James Bay Power Project on the arine and estuarine environment can be made.

The 1974 James Bay Summer Field Program nsisted of reoccupying the stations set up and occupied the 1972 and 1973 surveys. In September, discrete linity and oxygen samples, bottom samples and mechanal BT casts were taken at 16 stations located on two itudinal sections in the northern half of the Bay and two ngitudinal sections off La Grande-Rivière. Phytoplankton, oplankton and water samples for nutrients analysis were o collected and sent to the Arctic Biological Station, FRD. The University of Quebec at Rimouski was awarded a contract to analyze the 1972 and 1973 data in order to map the geostrophic current in the northern portion of the Bay and to determine by indirect methods the transport and coupling between James and Hudson Bays.

Following a feasibility study in the winter of 1973, a number of stations were occupied on the shore-fast ice off Fort George. Salinity and temperature data were collected from January to May, with one station being occupied twice weekly for the 4-month period. Measurements at hourly intervals were also taken at this station over a 13-hour period for comparison with similar observations taken the previous summer.

A survey was undertaken in September to measure currents, salinity and temperature over periods of 13 hours at 15 stations in La Grande-Rivière and estuary. Owing to inclement weather, only 11 stations could be occupied, of which six spanned the full tidal cycle. An analysis of the data collected in the estuary is underway to determine the spatial and temporal variations in the extent of the surface freshwater layer and the degree of mixing with the underlying saline water.

A combined program involving the Canadian Hydrographic Service, the Gravity Division of the Earth Physics Branch of the Department of Energy, Mines and Resources, and the Oceanographic Research Section is being carried out this winter in James Bay. The oceanographic survey will involve through-the-ice measurements of temperature, salinity and dissolved oxygen over the entire Bay, including the Eastmain estuary and Rupert Bay. Current meters will be moored in the estuary of La Grande-Rivière to obtain *in situ* records for tidal stream analysis, and a vertical profiling station will be occupied over two consecutive tidal cycles.

James Bay Workshop, June 26, 1974

The First James Bay Workshop brought together scientists, who had worked since 1971 on the physical and biological oceanography of James Bay, to present their data, analyses and interpretations as completed to date. Scientists from the Atmospheric Environment Service, the Bedford Institute, the Arctic Biological Station, McGill University, the University of Quebec (Rimouski), the James Bay Development Corporation, Marine Sciences (Central Region), the Geophysical Limnology Section, and the Great Lakes Biolimnology Laboratory, attended the one-day workshop to delineate present projects, propose future programs and discuss areas requiring further study.

HUDSON BAY OCEANOGRAPHIC STUDIES

Planning has been undertaken in 1974 by the Oceanographic Research Section to participate in a

multidisciplinary summer survey in Hudson Bay. The general objective of the oceanographic program is to increase our understanding and the predictability of the physical oceanographic processes in this mid-Arctic inland sea. This research will enable us to assess the environmental impact of accidents resulting from increased activity in hydrocarbon drilling, marine traffic, pipeline construction, and hydroelectric development. The program in 1975 will be oriented to the field-testing of new instruments and to the collection of base-line oceanographic data.

OCEANOGRAPHIC INSTRUMENTATION DEVELOPMENT

The Instrumentation Development Unit of the Hydrodynamics Section is a support group for supplying and/or developing the required data collection instruments for Hydrodynamics and Oceanographic projects. During 1974, the Unit supplied the St. Lawrence Current Survey with 12 Aanderaa current meters (*in situ*), 3 Endeco current meters (hand-held) and 2 R.S.5 profiling salinometers. All these instruments were thoroughly calibrated pre-season and post-season. A report is in preparation on the total calibration procedure, and first indications are that a small difference exists at high speeds between pre-calibration and post-calibration and between the published and tow tank calibration curves. The James Bay Winter Study, February 1975, will be supplied with 7 Aanderaa current meters and 2 R.S.5 salinometers. The

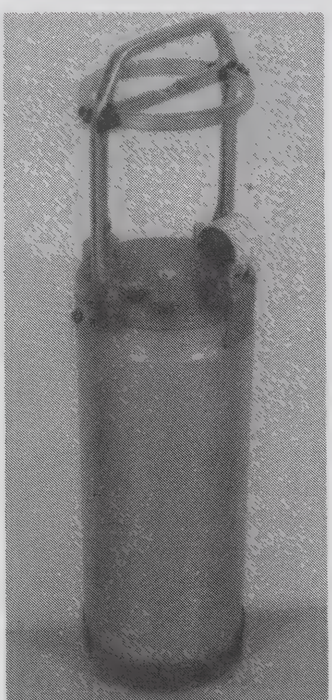


Figure 15. Modified Aanderaa R.C.M.

Aanderaa current meters, 6 of which were converted t profiling C.T.D. units with a printer output at the surfac underwent simulated arctic tests and calibration (Fig. 15

A surface-referenced mooring evaluation project wa undertaken by the Instrumentation Unit, as a result of request from scientific staff to have a mooring capable c holding instrumentation at a constant depth irrespective c tidal movements. The mooring configuration was designe during 1973, but was updated in 1974. The instrumen supplied to this project were 1 Aanderaa current meter (*i situ*), 1 Endeco 105 (*in situ*) current meter, 3 tri-axi accelerometers, 2 inclinometers, a high-speed 100-chann data logger, 1 dual buffered tape drive and periphera control systems. In addition, 1 high-speed data logge 1 dual buffered tape drive, 1 inclinometer and 1 tri-axi accelerometer were supplied for the Pitch and Roll Proje conducted by the Hydrography Development Unit, Centr Region. The high-speed data logger and dual buffered tap drive were supplied to IWD Engineering Services Sectio for its Tower Analysis Project.

DEVELOPMENT OF MANUAL TECHNIQUES FOR THE REAL TIME PREDICTION OF STORM SURGES ON THE GREAT LAKES

Flooding and erosion problems on the Great Lake resulting from short-term rises in water level superimpose on abnormally high water levels in 1973 and 1974, hav created an urgent need for forecasting these short-terr changes in real time.

A manual technique using a statistical approach t derive regression relationships has been developed. The lev changes for Lakes Ontario, Erie, Huron and for Georgia Bay were calculated from values of the sea level pressur and air-water temperature differences with lag times c 0 and 6 hours as independent variables. For Lake St. Clai hourly winds at Windsor with lag times of 0 and 1 ho replaced the sea level pressure as predictors.

The proportion of variation of the water levels in th various lakes accounted for by this method ranges fro 55% to 75%. The comparison of observed and predicte levels has been generally good with the best correlation c peak levels obtained for Lake St. Clair. A drag coefficie value of 2.46×10^{-3} has also been derived for Lake St. Clai The standard errors of estimate for all of the lakes, excep Lake Erie, range from 0.2 ft to 0.3 ft, whereas the standar error is close to 0.6 ft for Lake Erie.

TWO-DIMENSIONAL NUMERICAL TIDAL MODEL FOR THE HUDSON AND JAMES BAY SYSTEM

The dynamical equations used in this model are th vertically integrated forms of the equations of motion ar

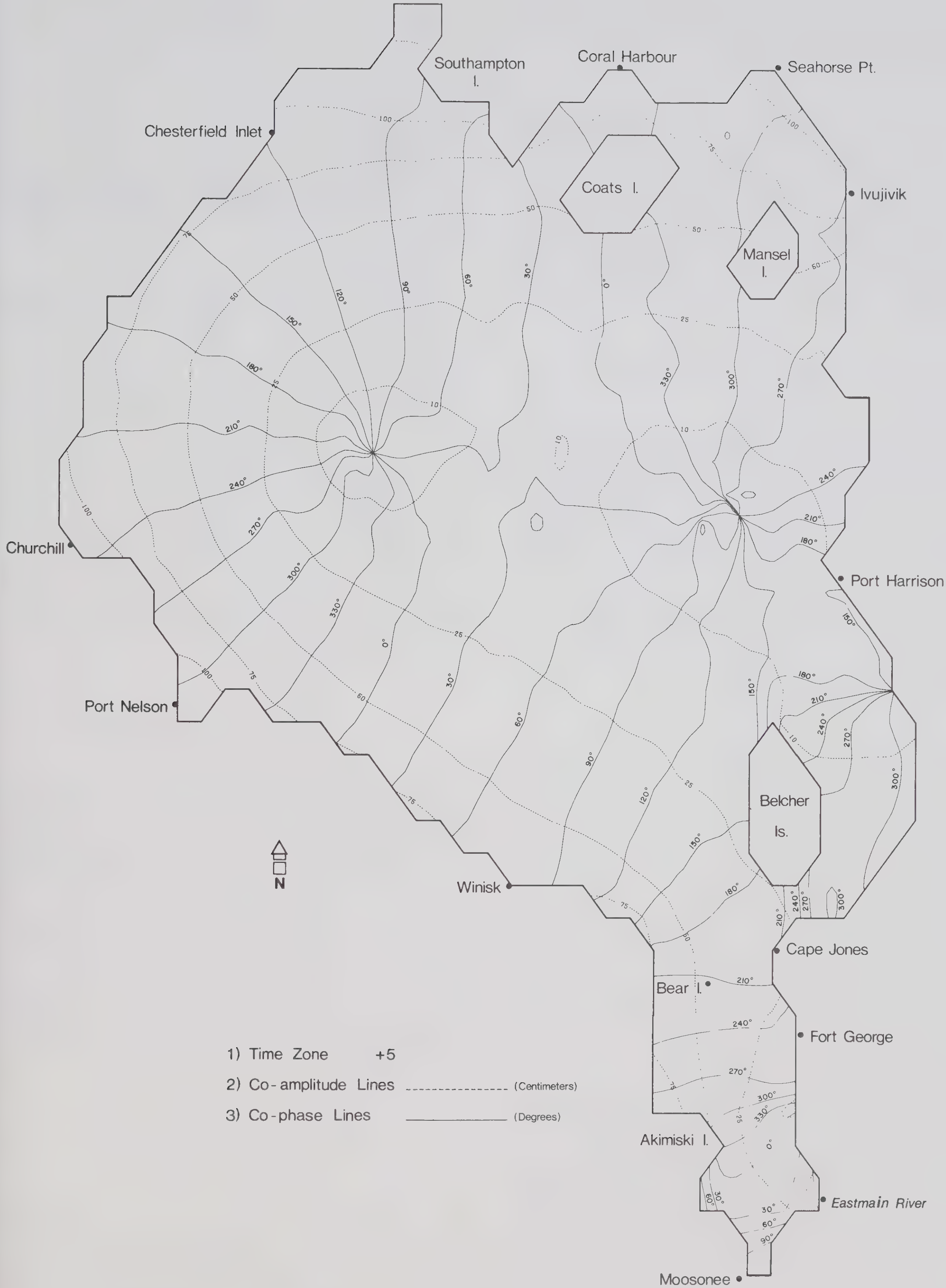


Figure 16. Hudson and James Bay numerical model.

continuity in spherical polar co-ordinates. A linearized form of bottom friction was used, and since there is no absolute way of choosing a friction coefficient, it was varied over a range of 0.01 cm/sec to 1.0 cm/sec.

The co-tidal diagram shows the co-phase and co-amplitude lines for the M_2 (semi-diurnal) tide using a friction coefficient of $R = 0.1$. The simple two-dimensional numerical model qualitatively reproduces the M_2 and K_1 (diurnal) tidal propagation in Hudson and James Bays (Fig. 16). Although at this stage precise station agreement is not achieved, the model results can be used to construct appropriate co-tidal charts and to analyze tidal propagation in the system.

ST. LAWRENCE CURRENT SURVEY, 1974

One of the primary objectives of the St. Lawrence Estuary Program is to provide an updated tidal current atlas of the middle estuary for use as a navigational aid, in the prediction of oil slick movement, and in the design of deep water ports. Another objective is to study the spatial and temporal variability of the astronomically induced tides and currents and the effects of meteorological forces on these tides and currents. In addition, the net non-tidal circulation patterns and their variability because of discharge, man-made changes in the bathymetry, and season are to be studied. Also, the program provides for base-line oceanographic measurements to be taken.

In the data processing field, the Aanderaa current meter data-handling programs were combined into a coherent system and preliminary documentation of the system has been completed. Edited current data files can be produced for Aanderaa, Plessey and Geodyne current meters. After edited files are created, tidal streams analysis and power spectral analysis are performed (Fig. 17), and progressive vector diagrams can be produced. A complementary data-handling system for Endeco direct readout current meter data was also developed. Plots of the vertical profiles of current, salinity, and temperatures can be made. In addition, a contouring program produces displays of the time variability of isohalines and isotherms.

The field work, operationally supervised by a senior hydrographer, consisted of two and one-half months of current measurement in the Pointe-au-Pic area. Eleven Aanderaa RCM-4 current meters were deployed, ten were recovered, and one meter was replaced under warranty by Aanderaa Instruments of Norway. The meters were distributed over four moorings. Thirty 13-hour stations were occupied in the measurement of current speed and direction, salinity, and temperature at each one-tenth of the depth.

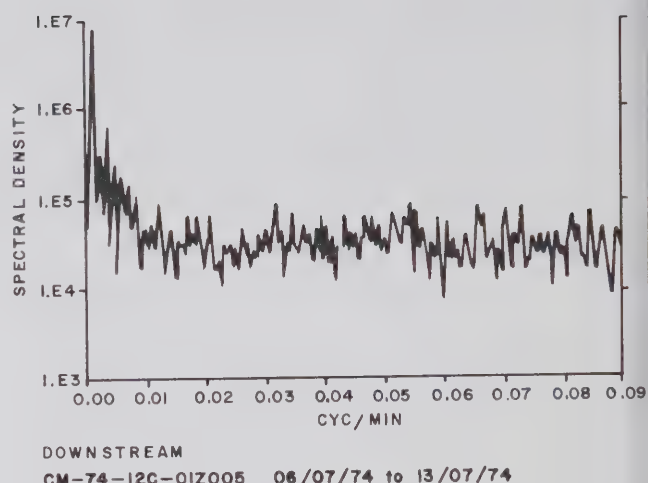


Figure 17. Spectral density of current velocity at Goose Cape, St. Lawrence Current Survey, 1974.

Analysis of the data is progressing, and data reports for both the 1973 and 1974 surveys should be published early in 1975. The preliminary analysis has been completed and indicates that some interesting circulation patterns exist in the middle estuary. In addition, some of the data suggest internal waves may be occurring there. Further analysis, however, is required to determine the true nature of these phenomena.

OPERATION PREPAREDNESS

The Hydrodynamics Section, through numerical modelling and a field program, is supplying current data to Operation Preparedness so that oil slick movement on the St. Clair-Detroit River system can be predicted (Fig. 18). The development of a two-dimensional implicit river model is completed, and a second contract is being let for the testing and application of this model to the St. Clair-Detroit River system. A one-dimensional river model has been developed and programmed in-house and will be tested and applied to the rivers early in the new year. A field survey on the St. Clair River was carried out in conjunction with EPS in August 1974. Data from this survey have been incorporated into a data report.

SURVEY ELECTRONICS SUPPORT TO MARINE SCIENCES

Owing to the introduction of major new systems and the operation of a number of large and sophisticated surveys, the Survey Electronics Section was busy again this year. Some of the new equipment acquired included 4 Miniranger systems, 2 sets of CA1000 Tellurometers

Figure 18. Surface currents at Sombra, St. Clair River, August 13-16, 1974.

3 new Ross Sounders and 4 digitizers, 3 INDAPS logging systems and a processing system, a number of new VHF radio systems and new gyro compasses and radars. Also during 1974, the Electronics Shop assumed responsibility for the three Digital Equipment Corporation computers. To learn this new technology, a number of training programs were undertaken. In addition to an RPS and a Tellurometer course provided to all of the staff, individual technicians undertook Minifix and Interdata courses and five technicians attended a course in logic provided by Hewlett Packard.

The *Chesterfield Inlet Survey* required considerable electronic support, using 2 Miniranger systems, 2 HAAPS systems and a processor, Ross sounders and a full-time field technician. The intention was to use a Highfix system. This system was not used, however, due to the success achieved with the Miniranger systems. The electronics on this survey operated with minimum down time, contributing to the successful completion of a two-year program in one year.

The *Lake Winnipeg (North) Survey* also employed a full-time technician and made extensive use of electronic equipment. The survey used a Minifix system with 60-foot towers, and redesigned matching units. This resulted in useable ranges in excess of 60 miles, whereas a 35-mile range was previously the maximum. The survey also employed the INDAPS logging system, although several problems were experienced because the system was new. A Minifix Slave unit was lost during high water due to its location on low terrain. An electronics technician was also supplied to the Lake Winnipeg Harbour Survey. Equipment maintained included Edo sounders, RPS, Hydrodist MRB 2's and new Hydrodist MRB 201's. Considerable problems existed in the general functioning of the MRB 201's.

The *Lake Huron Survey* used a high-power Minifix transmitter in conjunction with 70-foot towers to give extensive coverage in the order of 70 miles or more. Problems resulted from high towers, heavy lightning activity on Lake Huron and interference because of high power. In addition to the Minifix, the survey also employed HAAPS loggers and Ross digitizers and sounders. The technician for this survey was supplied on call from Burlington.

The *St. Lawrence River Survey* used Minirangers, RPS and Hydrodists in conjunction with Edo sounders. It became necessary to remove the RPS from service due to an interference problem with a similar system of the Ministry of Transport.

In addition to these surveys, electronic support was provided to the Local Survey in Toronto Harbour and to both Revisory Surveys.

SURVEY ELECTRONICS SUPPORT TO IWD PROGRAM

As in the past, this Section was responsible for all navi gational electronics on the LIMNOS, MARTIN KARLSEN and the large launches employed in scientific programs Three launches working out of Wheatley on scientifi programs were supported with a Miniranger and an RPS chain. A launch used by a Fisheries program at Nanticok was similarly supported.

Survey Electronics Development Programs

The Electronics Shop endeavours to undertake small amount of developmental work each year. This year considerable developmental work was carried out t increase the maximum stable range of the Minifix system The 30-foot telescoping Minifix antenna was replaced wit 70-foot towers and rebuilt tuning units, with signal increase in the order of 10 db being achieved. By raising the outpu power of the system from 50 watts to 100 watts, significant additional signal gain was observed. As a resul of these tests, both Minifix systems were modified for us with 70-foot towers and one of these systems incorporate 100-watt transmitters (Fig. 19).

During the year, two test boxes for testing th HAAPS were developed. One injects signals into th HAAPS and the second monitors the outputs. A standar remote readout for RPS and Miniranger systems was als developed. At the present time, work is continuing on th development of a new, more stable trigger circuit for th Minifix receivers.

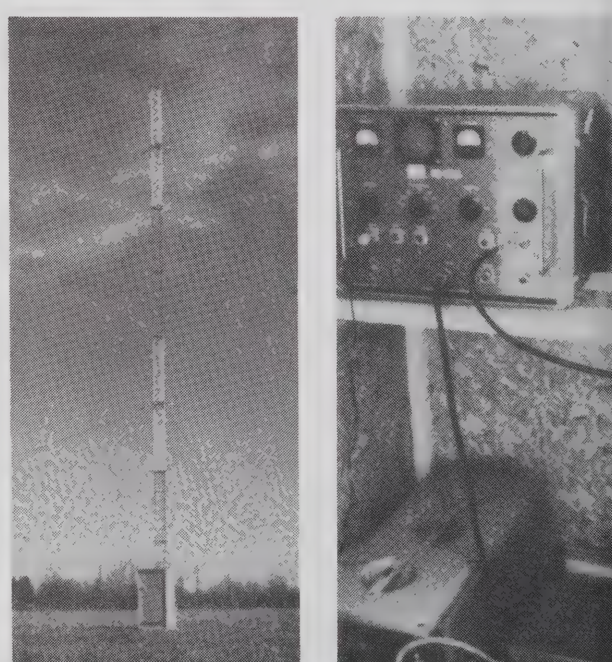


Figure 19. High-power Minifix tower and equipment.

SHIP DIVISION

This year, all of the Division's outboard engine work was placed with outside contractors, which alleviated much of the work load on shop personnel, allowing more time for carrying out modifications and design work on major launches.

The repowering modifications on three Hydro launches were made, based on exhaustive testing, both under simulated load conditions and under field conditions in the latter part of the 1973 season. It was later determined, however, that actual load requirements were far in excess of those predicted and that the engines for the three latest boats were of a different model than the one tested, although they were identical in appearance. Consequently, all three of these engines failed after an approximate period of 30 hours under actual field conditions, although HYDRO II, the original boat that was outfitted and tested, was still operating at the close of the season.

SURGE and STURDY were rebuilt during the early part of the year, with respect to decks and houses, and STURDY was re-engined using the original diesel engines from HYDRO I and HYDRO II. During a break-in period in the lower St. Lawrence, STURDY experienced lubricating oil troubles, a problem similar to one that occurred on the East Coast when the engine required changing after a seize-up.

Lubricating oil problems persisted even with the new engine, until it was determined that a mismatched dip stick was giving a false oil level reading. With the exception of a clutch failure on SURGE, which was repaired at Chesterfield Inlet by the shop mechanic, both vessels operated without problems for the remainder of the season.

NEW ACQUISITION

CSS BAYFIELD modifications were delayed in waiting for the awarding of the contract for electrical repairs, modifications to the main switchboard, and necessary repairs for the vessel's recertification from a yacht to a scientific research vessel under the Canada Shipping Act (Fig. 20). After her return to Burlington from Port Weller where modifications, provisioning and outfitting were carried out, the vessel departed for the lower St. Lawrence on a 76-day Tidal Current Survey. During this time, valuable experience was obtained both in operating the vessel and in determining the extent of further modifications necessary to make the vessel an even more valuable addition to the fleet. Some of these modifications were made during the dry-docking of the vessel in the latter part of November, with the addition of Ross and Atlas transducers and a Sperry Doppler Speed Log.

Figure 20. CSS BAYFIELD.

CSL SURF

This 38-foot steel-hulled launch was acquired in a semi-completed condition early in the year and arrived at Burlington following the start of the season, too late for field operations. Following a fitting-out period, however, the vessel created great interest in both hydrographic and scientific circles mainly because of her spaciousness and large working area in the aft cockpit.

NELSON 34

This GRF diesel-powered semi-displacement hull vessel was delivered in September, following trials conducted by the supplier where a top speed of 22.5 mph was attained. Upon acceptance trials at CCIW, the vessel was found to be a fine craft to handle, particularly smooth through the water, and to have a turning circle equal to two boat lengths.

Following acceptance, the vessel was subjected to even more stringent testing than required by the purchase agreement. Repeated full ahead to full astern movements resulted in an early failure of the transmission. Repairs were carried out, however, under warrantee, and the vessel performed adequately until hauled out for outfitting as a sophisticated hydrographic vessel. The major modifications were as follows:

1) hull trepanned and two transducer wells and transducers installed,

2) fuel tanks modified to double capacity,

3) upper steering position moved,

4) forward cabin stripped and rebuilt to accommodate sounders, instrument racks, chart tables and lockers,

5) radar tower constructed and installed on aft cabin top,

6) cockpit decking modified,

7) engine and generator casing modified completely for access, and

8) 24-volt scientific power to be separated from ship's power to be supplied from auxiliary generator and constavolt unit.

This vessel will be ready for full equipment trials immediately at the start of the 1975 season.

CSS ADVENT

CSS ADVENT performed efficiently during the season with down time limited to one day and four hours in total, the major portion consisting of the run from Goderich to Sarnia and return for a propeller change following the striking of an unidentified object in deep water. Two interesting points were noted during this season's operation: 1) using the larger spare props at lower engine rev/sec not only increased the vessel's speed by nearly 3 knots, but also significantly lowered fuel consumption and 2) with a barely noticeable scrape on the tip of one blade, engine rpm dropped from 2200 rpm to 1900 rpm, with consequent loss of speed.

CSS LIMNOS

The vessel operated without problems during the early part of the season, dry-docking in May for the installation of the lower spool piece and sea valve for a Magnavox Doppler transducer, part of the Sat/Nav System. The actual transducer and other equipment were installed in late June.

A diver's inspection located a crack in a previously repaired propeller, so that the spare propeller was installed during dry-docking.

Following the dry-docking, problems occurred during a seismic survey, when power cables to the deck services fractured. Failure of the starboard steering gear bearings and oil leakage from the port harbour master unit were further problems encountered. A diver's examination, however, revealed no physical damage to the lower units.

Repairs were made on the vessel's arrival at Burlington, and the vessel operated until the end of August, when a routine inspection revealed a broken tooth in the upper gears of the Port Harbour Master Gear. Repairs were carried out without loss of time.

Two consecutive engine failures resulted in a loss of three weeks at the end of October and beginning of November, necessitating extensive repairs. The vessel did complete her season's work, however, with an extended field season.

ADMINISTRATION DIVISION

The loss of four senior supervisors and a number of key personnel to promotion at CCIW greatly increased the Administration's work load, decreasing general efficiency in the first half of 1974. Concurrently, Marine Sciences Headquarters Administrative Unit, providing guidance and other support, experienced a similar staff reduction owing to the formation of Ocean and Aquatic Affairs, which placed more emphasis on regional autonomy. Capable replacement staff have since been gradually obtained from within and outside the government.

PERSONNEL

The Regional Personnel Office was moved to CCIW, Central Personnel Office on August 26, 1974. Master personnel files were transferred from Marine Sciences Headquarters (Ottawa) to CCIW in late September 1974. Central Region Administration will provide the interface work load on a continuing basis.

In view of the seasonal nature of field operations, a large turnover in staff was experienced, requiring close coordination between the Central Personnel Office and Central Region Administration. The establishment of a personnel interface office was found to be essential to provide proper control of management records and other personnel activity.

A total of 164 man years account for 155 staffing actions as follows:

Employees	Number
Full-Time Continuing	13
Term	55
Seasonal and Ships Crew	53
Career and Co-op students	26
Contract personnel	8

Peak staff level reached 215 during the summer of 1974.

Classification was active, as 69 positions were submitted for review or classification.

There were 24 promotions and 9 acting appointments, and 15 employees were granted acting pay.

A total of 23 personnel accidents were reported.

ACCOUNTS

Of a total Regional budget of $5 million annually, $2.8 million was processed through the Accounts Office, representing $2.3 million for O & M purchases and ships charters, and $500,000 in capital expenditures. The remaining $2.2 million represents salaries and other personnel costs. The Accounts Office was also responsible for the processing of an additional $375,000 in funds transferred for special projects supporting other departments, agencies and DOE Services. Over the past year, the staff of three accounts clerks have processed approximately 3000 supplies invoices and 400 travel claims. Furthermore, the staff were involved in the preparation, payment and supervision of 20 field accounts and 11 sub-accounts.

With the decrease in Ocean and Aquatic Affairs Headquarters involvement in Regional financial matters, the Accounts Office has increased its production of financial information for various segments of departmental Headquarters and for local management consumption.

SUPPLY SERVICE

A central procurement and supply service consisting of six staff members maintained field support to all Hydrographic field parties, James Bay winter projects and Ships operations, accounting for 34 field inventories. Inventories contained about 6000 accountable line items with stock value reaching $14 million. Control of 30 Regional individual Standing Offers to maintain fuel, oils, food, material and field stores was provided.

The scope of 1974 procurement, valued at $1.9 million, is as follows:

Items	Amount
30 Regional individual Standing Offers	$ 250,000
50 Purchases off National Master Standing Offers	50,000
00 Regular Requisitions and Contracts	1,480,000
00 Government of Canada Purchase Orders	60,000
Direct transportation costs	60,000
	$1,900,000

Approximately $100,000 in value of obsolete equipment was processed through Crown Assets Disposal.

MOBILE EQUIPMENT

The Regional mobile fleet consists of 30 vehicles ranging from station wagons and travel-alls to 2-ton trucks; 53 boat-hauling trailers and 16 workshop, living and office trailers. Additionally, 5 vehicles were leased to meet operational needs. All equipment was mobile in Manitoba, Ontario, Quebec and the Northwest Territories. Most maintenance was conducted through contract.

During 1974, Central Region vehicles travelled 375,103 miles. Ten accidents were recorded costing $8003.49. Of this amount, $6500 is the estimated damage for one of the ten accidents. As of this date, the main factor causing this accident and the actual damage have not been determined. The main factors that caused the other accidents, assessed either party, were 1) inattention and 2) failure to yield. Although a degree of negligence exhibited in two of the ten accidents was assessed our drivers, it was judged to be of a minor nature and the drivers were not charged with damages.

During December, 29 user drivers attended a Defensive Driving Course conducted at CCIW by an Ontario Safety League instructor. Safety standards are constantly being examined to improve driving safety and standard operating procedures. No professional drivers were employed on staff, and therefore greater care was exercised in assigning user drivers to service vehicles.

SAFETY

Treasury Board emphasis on a more comprehensive attitude toward safe working practices has created increased activity at the departmental and regional levels. In response, both on site (CCIW) and at field operational level, managers during the year have shown considerable interest in accident prevention programs and in identifying areas of hazards peculiar to a marine-based operation.

Three accidents classed as serious and now under investigation were thought to have resulted from equipment failure. These involved a helicopter crash in the Arctic, a large launch and trailer under tow by road and the failure of a ladder at low tide.

Although numerous minor accidents were judged as work hazards, e.g., strains, cuts, bruises, etc., a number have developed into chronic ailments causing considerable loss of work and workmen's compensation activity, thus increasing concern for accident prevention measures among all supervisors and employees.

Environmental Quality Coordination Unit

Environmental Quality Coordination Unit

The Environmental Quality Coordination Unit (EQCU) is responsible for the integration and/or co-ordination of research results from components of CCIW with research results produced by other groups to be used by federal, provincial and municipal water managers and to assist in departmental and ministerial policy decisions. A second significant role is a liaison function for the research activities of CCIW. This is performed by providing assistance to the Director in discharging a number of his committee responsibilities, as well as by representing the 3ranch on a number of departmental, interdepartmental, ederal-provincial and international committees. In addition, EQCU provides assistance and advice to the Director on policy, program and other matters, provides echnical support to both IJC Great Lakes Boards and Reference Groups and provides general coordination of the activities being conducted by the Branch pursuant to the Great Lakes Water Quality Agreement.

GREAT LAKES WATER QUALITY AGREEMENT

EQCU continues to be extensively involved in IJC ctivities; the Unit provides technical support for the Canadian chairmen of the Great Lakes Water Quality oard, the Research Advisory Board (RAB), the Pollution rom Land Use Activities Reference Group and the Upper akes Reference Group and serves on a number of ub-committees that have been established. The Unit articipated in the preparation of major reports for the oards and Reference Groups of the IJC. These included he second annual report of the Water Quality Board, the hird semi-annual report of the RAB and the semi-annual eports and detailed study plans for both the Upper Lakes nd Pollution from Land Use Activities Reference Groups.

EQCU coordinates various aspects of the extensive esearch and surveillance program, as well as the Reference roup activities being undertaken pursuant to the Agree-ent. This has involved the preparation of program sub-issions for funding, status and progress reports and other ctivities.

CANADA-ONTARIO AGREEMENT

EQCU continued its coordinating role in support of e Canada-Ontario Agreement on Great Lakes Water Quality. Under the Agreement, a comprehensive research program has been developed concerning phosphorus removal processes, upgrading of sewage treatment facilities, advanced processes for treatment, the Sludge Handling and Land Disposal Program, and a Storm and Combined Sewer Research Program. Members of the Unit serve on the Technical Committee and the Sub-committees on Technology Transfer and Land Disposal of Sludge. Other activities involved administration and review of external contracts, assistance in the preparation of detailed financial statements and other administrative matters. Members also participated in the planning and management of a seminar on sewage sludge handling and land disposal, held in late September and attended by 400 people from industry, universities, and local, regional and national governments.

ENVIRONMENTAL CONTAMINANTS

The main concern in this field was the preparation of a report on the "Status of Non-Medical Studies on Asbestos in the Great Lakes and the St. Lawrence River." The report briefly describes hazards from occupational and non-occupational exposure to asbestos and the distribution of asbestos fibres in the Great Lakes-St. Lawrence River region, and documents some of the identification techniques used.

Members of the Unit also participated in departmental and interdepartmental activities directed toward the development of a Water Quality Agreement for hazardous polluting substances.

The Unit is responsible for general coordination of research activities related to environmental contaminants carried out at CCIW and has been actively involved in the coordination of these efforts with other departments and agencies.

WORLD HEALTH ORGANIZATION, INTERNATIONAL COLLABORATION CENTRE

A new dimension was added to EQCU activities this past year due to the designation of CCIW as the International Collaboration Centre for Surface and Ground Water Quality by the World Health Organization (WHO/ICC). The principal activity involved the preparation

of a document entitled "Guide to Water Quality Management." It is expected that a Coordinator for these activities will be appointed early in 1975.

OTHER ACTIVITIES

With the establishment of the Environmental Assessment and Review Process, the Unit provided the Chairman for the Ontario Region Screening and Coordinating Committee. Various discussion papers were presented for departmental review, and procedures and terms of reference for the Screening and Coordinating Committee were outlined.

Considerable effort was devoted to the preparation and coordination of material for the development of the EMS Green Paper. All of the staff actively participated in working groups, which outlined fifteen issues with which the Environmental Management Service should be concerned in the near future. A consolidated EMS Green Paper, representative of input from the five establishments within EMS Ontario Region, was prepared for the Regional Director General.

Members of the Unit participated in the Canada-Ontario Fisheries Strategic Planning Work Group. These strategic planning sessions defined goals, objectives and issues regarding fisheries in Ontario.

EQCU continued to represent CCIW on a number of interdepartmental committees, carried out a number of international functions pertinent to the work at CCIW and conducted extensive information programs entailing speeches and papers at a number of conferences and symposia throughout 1974.

Public Relations Unit

Public Relations Unit

As the public becomes increasingly aware of the importance of scientific research to effective environmental management, CCIW must constantly inform Canadian taxpayers of what has been accomplished and what remains to be done. In 1974, the Public Relations Unit found its task more challenging than usual, owing to the restrictions of reduced budgets and manpower as the Department's economy drive took effect.

Nevertheless, in June, the Public Visits Program completed a highly successful 10-month series of illustrated lectures given by scientists on topics ranging from hydraulics to microbiology to hydrography. Supported by special films, exhibits and demonstration displays, these presentations were enjoyed by over 3200 people from within driving range of CCIW.

Although local audiences were relatively well served by such programs, as well as by a vigorous effort in school visits and public speaking engagements, it was decided that the national public needed more attention. Thus the reduced resources of the Unit were focused on generating news and reports that would be conveyed by the mass communication media, both print and electronic.

Fortunately, this decision coincided with the completion of two films entitled "Not Man's to Command" and "Second Frontier." These films describe, respectively, the challenge of trying to regulate partially the fluctuating levels in the Great Lakes, and the work and purpose of CCIW. In association with the National Film Board and with the co-operation of the Ontario public library system, as well as television stations and networks, "Not Man's to Command" had already been seen by audiences numbering several hundred thousand by the end of the year.

"Second Frontier" will be distributed to a national rather than local public, explaining to its audiences not only what is done in CCIW laboratories, ships and field operations, but also why it is done. The film concludes with the important message that the effectiveness of CCIW work depends, to a large extent, on public attitudes toward the use and management of water.

As always, media liaison formed a large part of the year's work. Several news releases were issued and numerous interviews were arranged. Among the many media representatives received was a television film crew from Radio-Télévision Belge.

In response to individual requests during 1974, over 2200 replies were mailed from the Unit, a 50% increase over 1973. In addition, an estimated equivalent number of requests were handled by telephone.

Along with its regular work, the Unit was also asked in the fall to assist the International Joint Commission in a series of public hearings on the topic of further regulation of Great Lakes levels.

Appendix A • CCIW Staff List

;CIW Staff List

ENVIRONMENTAL MANAGEMENT SERVICE

CCIW BRANCH

irector, CCIW Branch — Dr. A. R. LeFeuvre
Secretary — Mrs. C. J. McMunn
nior Scientist — Dr. R. A. Vollenweider
Secretary — Mrs. S. M. Horne
eceptionist — Mrs. S. Magee

PUBLIC RELATIONS UNIT

ead — A. R. Kirby
formation Assistant — Mrs. I. Powell
isual Aids Officer — I. F. McGregor

ENVIRONMENTAL QUALITY COORDINATION UNIT

ead — Dr. A. R. LeFeuvre (until July)
Secretary — Mrs. H. Hetherington (until October)
— Mrs. J. Fiddes (Term)

tenographic Staff — Mrs. S. Austin

oordinators — J. W. Schmidt (A/Head after July)
J. D. Wiebe
G. A. Jones

cientific Assistant — J. Osellame

raining Position — Dr. R. R. Weiler (until November)
Dr. K. L. E. Kaiser (after November)

anada-Ontario Agreement Personnel — Mrs. B. Jones
Mr. D. F. Rhodes

HYDRAULICS DIVISION

hief — T.M. Dick
Secretary — Mrs. A. Mueller
dministrative Officer — Mrs. E. Eidsforth

cientific Staff

.K. Jonys — Sediment
.G. Krishnappan — Dispersion
.L. Lau — Fluid Dynamics
. Marsalek — Urban Runoff
I.G. Skafel — Wave Dynamics
i. Tsang — Ice Studies

National Hydrometric Service Staff

Head — P. Engel
Towing Tank Supervisor — C. Bil
Carriage Operator — B. Leaney

Technical Services Section

Head — C. DeZeeuw
Research Technicians — E. Bohm, F. Dunnett, W. Ellis, D. Fekyt, J. Huehn, A. McEwen, W. Stage, G. Voros, W. Welmers

SOCIAL SCIENCES DIVISION

Chief — J.P.H. Batteke — economic studies and information systems
Secretary — Mrs. R. Riggs
D.E. Coleman — dynamic modelling and geographic studies
T.D. Leah — environmental contaminants
T.A. Muir — economic studies
D.L. Robinson — environmental management and planning
R. Shimizu — legislative and institutional studies
M.R. Sinclair — environmental attitudes and behaviour; public participation
R.A. Sudar — coastal zone management; planning
Support Staff — Mrs. S.D. Begin
Mrs. J.I. Thomblison

SCIENTIFIC OPERATIONS DIVISION

Chief — Dr. R.K. Lane
Secretary — Mrs. R.E. Morrison
Administrative Officer — Miss L. Ram

Microbiology Laboratories

Head — B.J. Dutka — Methods development, water quality assessment
Secretary — Mrs. M.B. Jurkovic
Dr. W.E. Lowe — Taxonomy Unit
Dr. S.S. Rao — Water Quality Assessment Unit
Dr. A.A. Qureshi — Mycology Unit (PDF)

Dr. D.A. Rokosh — Microbial fermentation
Dr. A. El-Shaarawi — Statistician (to spring 1974)
Technical Staff
— Mrs. D.J. Nuttley, Mr. A.A. Jurkovic, Mr. J.P. Henderson, Mr. K.K. Kwan, Ms. K.D. Switzer-Howse, Mrs. D.E. Doerffer, Mr. S.R. Kuchma, Mr. R. McGinnis

Physical Sciences Laboratories Section

Head — Dr. R.W. Durham
Dr. F.A. Prantl — radiochemistry
T.W.S. Pang — electron microscopist
R.J. Goble — radiochemistry technologist
R. Miles — radiochemistry technician
J. Fitzgerald — radiochemistry technician
Dr. B.A. Silverberg — electron microscope (PDF)
Dr. S. Joshi — radiochemistry (PDF)

Technical Operations Section

Head — H.B. Macdonald
Secretary — Mrs. A. Stern (on strength March 1974)
— Mrs. L.C. Bouverat (transferred to GLBL, February 1974)
D.J. Cooper — Senior Operations Officer
D.J. Brooks — Operations Officer, CSS LIMNOS
D.H. Hanington — Operations Officer, MV MARTIN KARLSEN
J.T. Roe — Senior Diving Officer
D.J. Williams — Standards and Development Officer (transferred to GLBL, December 1974)
P.R. Youakim — Program Coordinator
L.E. Benner — Sensor Network Unit
T.J. Carew — HMCS PORTE DAUPHINE
R.G. Chapil — Sensor Network Unit
H.K. Cho to May 1974
B.E. Clemmens — Pacific Region
J.R. Compton-Smith — Diving/MV MARTIN KARLSEN
F.J. DeVree — MV MARTIN KARLSEN
F.H. Don — Diving/MARTIN KARLSEN
H.E. Greencorn — Shop
P.M. Healey — MV MARTIN KARLSEN
G.J. Koteles — Point Source Studies
L.J. Lomas — Shop Foreman
M.R. Mawhinney — HMCS PORTE DAUPHINE
B.H. Moore — CSS LIMNOS
H.K. Nicholson — Sensor Network Unit
G.M. Perigo — Shop
S.B. Smith — Project Quinte — Biochemical Processes in Lakes
W.B. Taylor — Sensor Network Unit
M.R. Thompson — CSS LIMNOS
S.P. Withers — Western Region
H.W. Zimmermann — MV MARTIN KARLSEN

Remote Sensing Section

Head — Dr. K.P.B. Thomson (Acting) — remote sensing and lake optical studies, transferred to CCRS, September 1974
Dr. R.P. Bukata — satellite studies
Dr. W.R. McNeil — contract scientist from W.R. McNeil & Associates Inc. - optical studies
Dr. H. Howard-Lock — contract scientist, now at McMaster University — oil spills
Mr. G. Bobba — Land Drainage Reference studies
Technical Staff — H.W. MacPhail, J. Jerome, E. Bruton, W. Boham

Data Management Section

Head — Dr. H.S. Weiler (to July 1974)
Mrs. H. Comba (Acting from July 1974)
Computer Applications — H. Comba, K. Beal, G.S. Beal, J. Dowell, B. Hanson, E. Pyde (to July 1974), B. Duffield, K. Miles
Data Archiving — W. Nagel, J. Byron, M.G. Smith
Special Projects — R. Gottinger, D. Jordan

SCIENTIFIC SUPPORT DIVISION

Chief — A.S. Atkinson
Secretary — Mrs. C. Dean

Scientific Services Section

Instrumentation Research and Development

Research and Development Engineer — K.N. Birch

Computer Services

Head and Software Specialist — H.C. Pulley
Operations Supervisor — M. Kinder
Computer Console Operators — P. Moody, M. Thompson, P. Varga
Peripheral and Keypunch Operator — P. Kirkwood

Library Services

Head Librarian — Mrs. E.A.C. Fosdick
Technical Services Librarian — L.M. Brownlee
Technical Services Clerk — B.J. Davis
Cataloguing Clerk — J. Culp
Reference and Circulation Clerk — L.J. Watson

Engineering Services Section

Head — J.S. Ford
Secretary — S. McVey

Electronic Engineering

Head — A.S. Watson
Instrument Maintenance and Calibration — A. Eatock
Digital Systems/Logic Design — P. Dupuis
Electro-optical Design — R. Desrosiers
Digital Systems/Logic Design — J. Valdmanis
Electro-acoustic Design — B. White
Technologists — K. Mollon, J. Kiaz, M. Moschos, A. Tyler, M. Larocque, M. Pedrosa, A. Fletcher, E. Smith, T. Nudds

Mechanical Engineering

Head — A.E. Pashley
Mechanical Engineers — P. Ward-Whate, B. Brady, W. Gibson
Technologists — R. Boucher, J. Heidt, H. Savile
Tradesmen — D.H. Whyte, R.V. Chumley, K.K.P. Kalter, J. Bidinost

Drafting and Illustrating

Supervisor — W.D. Finn
Draftsmen — A. Gris, M. Donnely, J. Bodnaruk, P. Carney

Technical Services Section

Head — D.F. Stewart
Building Maintenance — G. Clim, J. Slaz
Stationary Plant Supervisor — B. Bodolay
Stationary Plant Support Staff — A. Hyslop, K. Fess, L. Goghegan, M. Connors, D. Clewley, B. MacDougall
Security — S/Sgt. K. Loughren and 12 members of the Canadian Corps of Commissionaires on rotation

Staff Services

Financial Services
Supervisor — A. Mitchell
CCIW Accounts Staff — D. Jefferson, E. Mulvaney, R. Money, C. Furlong, M. Stepko, Y. Hutton

Central Registry and Duplicating

Supervisor — E. Rae
Support Staff — B. Titley, H. Green, J.R. Sims, M. Solvason

Stores

Material Manager — C. Hicks
Procurement — J. Doerr
Inventory Control Clerk — B. Will
Driver — J. Ames
Warehouse — A. Mayes, R. Haswell
Support Staff — F. Kushner, T.A. Williams, R. Legg

LAKES RESEARCH DIVISION

Chief — Dr. P.G. Sly — distribution and variance of lake bottom sediments
Secretary — Mrs. J.E. Cunningham

Scientific Assistant — Dr. M.E. Thompson — specific ion electrodes, low temperature aqueous geochemistry
Administrative Officer — Mr. F. Boyd

Regional Laboratories (CCIW Detachment, Winnipeg)

A/Head — Dr. T.A. Jackson — biogeochemical research
B.C. Kenney — physical limnology (educational leave — University of Waterloo)
W. Warwick — paleoecological research on Bay of Quinte, "dissertation research for Ph.D." — interpretation of chironomid fauna
Support Staff — W.R. McGregor (left May 1974), J. Mollison, R. Woychuk

Regional Laboratories (CCIW Detachment, Vancouver)

Head — Dr. B.E. St. John — trace element geochemistry
Dr. C. Pharo — sedimentary geology of lakes and rivers
Dr. E.C. Carmack — (November 1974) — physics of fjord lakes
C.B.J. Gray — (May 1974) — organic geochemistry and chemical limnology of B.C. lakes
Dr. R.J. Daley — (May 1974) — primary and secondary production processes in lakes
Support Staff — G. Bengert (left September 1974), S. Jasper, B. Clemens

Paleoenvironmental Research

Head – Dr. L.D. Delorme – ostracode taxonomy and ecology, use of shelled invertebrates in defining trophic state indices and paleoclimatology.

Dr. L.L. Kalas – freshwater and terrestrial mollusc taxonomy and ecology

V.W. Hanson – programmer – systems analyst; paleoenvironmental research

Support Staff – M. Denford

APPLIED LIMNOLOGY AND PHYSICAL PROCESSES SECTION

Head – Dr. G.K. Rodgers – physical and descriptive limnology

Secretary – Mrs. S.M. Tapping

Applied Limnology Unit

Head – F.C. Elder – energy budgets of lakes

Dr. E.B. Bennett – circulation

Dr. N.M. Burns – nutrient cycles, especially organic sedimentation

H.H. Dobson – nutrients and water quality

A.S. Fraser – analysis of monitor cruise data: lower lakes

Dr. W.A. Glooschenko – toxic chemicals: chemical-biological relationships in lakes

D.G. Robertson – near-shore thermal regimes

Dr. P. Stadelmann – (leave of absence April 1974) – phytosynthetic production

N.D. Warry – analysis of monitor cruise data: upper lakes

Support Staff – R.G. Chapil, F. Chiocchio, J.A. Gilbert, M.F. Kerman, Mrs. H. Lam, F. Rosa, W.M. Schertzer, Miss S. Patrick

Physical Processes Unit

Head – Dr. P.F. Hamblin – circulation and seiches

Dr. J.O. Blanton – thermal structure and demonstration basin studies (left May 10, 1974)

F.M. Boyce – internal waves and heat content

J.A. Bull – physical limnologist

Dr. M.A. Donelan – air-lake interaction

Dr. C.R. Murthy – diffusion and circulation

H.Y. Ng – Okanagan Basin studies and retention times

Support Staff – K.C. Miners, W.J. Moody, K.D.K. Johnson, J.S. Falloon

Systems Modelling Unit

Head – Dr. T.J. Simons – hydrodynamical modelling

L.N. Allen – model verification

Dr. D.C. Lam (PDF) – numerical modelling

SEDIMENTARY AND CHEMICAL PROCESSES SECTIO

Head – Dr. R.L. Thomas – distribution, occurrence an authigenesis of minerals, m jor elements and heavy meta

Secretary – Mrs. B. Blain

Sedimentary Processes Unit

A/Head – Dr. R.L. Thomas

Dr. T.W. Anderson (GSC) – palynology of recent sedimen

J.P. Coakley – distribution, occurrence and r lation to erosion, transport tion and deposition of acti sediments

Dr. V. Damiani (PDF) – sedimentology and applied ge chemistry of lakes (left Augu 15, 1974)

Dr. C.I. Dell – stratigraphic correlation an mineralogy, including clay mi eralogy, of recent sedimenta sequences

R.K. McMillan – geophysical instrumentation

Dr. J.-M. Jaquet (PDF) – mathematical geology and modelling of sedimentary processes

Dr. S. Guppy – suspended material in lakes (PDF as of October 1974)

Dr. N.A. Rukavina – interpretation of sediment c tributions in the nearshore are grain size analysis

A. Zeman – geotechnical and sedimentol ical studies of glacial and po glacial sediments

Support Staff – W. Booth, G. Duncan, Mr. G. LaHaie, R. Sandilands, D.A. St. Jacques, Mrs. L. Oelze, J. Horseman (GSC – left October 1974)

Toxic Substances Unit

Head – Dr. W.M.J. Strachan – organic chemistry applied lakes

Dr. Y.K. Chau – chemical and biochemical processes of trace metals the environment – compl ation and methylation

r. B. Brownlee — detergents and organic substances in freshwater systems
r. E. Nagy — oil-water studies
r. K. Kaiser — toxic substances (PCB's, pesticides, NTA) in the environment (as of November 1974 with EQCU)
. Saitoh — trace elements, especially mercury compounds in lakes
. Lum-Shue-Chan — metal organic interactions in natural water (on educational leave as of September 1974)
.E. Fox — organic compounds in lakes
ıpport Staff — J. Hart

eochemistry Unit

ead — Dr. A.L.W. Kemp — sedimentation rates and geochemical budgets
r. J.D.H. Williams — sediment-water interface exchanges; geochemical processes in sediments
·. J.O. Nriagu — stable isotopes; stabilities of authigenic minerals
·. V. Cheam — metal fulvate complexes; geochemistry of dredging
rs. A. Mudroch — geochemistry of dredging
·. P. Pang (PDF) — nitrogen transformation in lakes by isotope ratio method
ıpport Staff — T.W. Morton, J. Capobianco, Mrs. N. Harper, H. Wong, R. Coker, G. McInnis

ıtrient Dynamics Unit

ıad — Dr. D.R.S. Lean — phosphorus, carbon and nitrogen dynamics in lake ecosystems
. B.K. Burnison — microbial ecology
. R.R. Weiler — worked with EQCU until November 1974
. R.F. Platford — electrochemistry of mixed salt solutions
. R.M. Baxter — biodegradation of resin acids; phosphorus cycle in lakes
. C. Laio (PDF) — nitrogen metabolism in lakes
pport Staff — M. Charlton, T. Murphy (educational leave fall 1974) Miss K. McEacheran, Miss S. Jackman

WATER AND WASTEWATER TREATMENT RESEARCH SECTION

ad — Dr. Charles P. Fisher
Secretary — Mrs. Nancy Semenuk
. Aharon Netzer, Head, Research Contract Liaison Coordination Unit
Dr. Barry G. Oliver — Research Scientist
Dr. John Lawrence — Research Scientist
Dr. H. Kirk Johnston — Research Scientist
Mr. Paul Wilkinson — Research Technologist
Mr. Ernest Cosgrove — Research Technologist
Mr. Henri Huneault — Research Technologist
Mrs. Helle Tosine — Research Technologist
Dr. John Carey — Post Doctorate Fellow
Mr. Heng S. Lim — Project Engineer (contract)
Mr. Stephen Beszedits — Project Engineer (contract)
Mr. Henry Miyamoto — Project Engineer (contract)
Miss Karen Bothen — Assistant Research Technologist (contract)
Miss Martha Olijnyk — Assistant Research Technologist (contract)

ANALYTICAL METHODS RESEARCH SECTION

Head — Dr. S. Barabas
Secretary — Mrs. J.M. Giles
Research Scientists — Dr. B.K. Afghan, Dr. I. Sekerka, Dr. P.D. Goulden, Dr. R.S. Tobin, Dr. F.I. Onuska, Dr. A.W. Wolkoff
Research Technologists — D. Anthony, R. Larose, P. Brooksbank, J. Lechner, M. Comba, J. Ryan

INLAND WATERS DIRECTORATE, ONTARIO REGION

Director — D. M. Foulds
Secretary — Miss W. Grant
Administrative Officer, Ontario Region — W. A. Taylor

Water Planning and Management Branch

Toronto Office

A/Chief — N.P. Persoage (Burlington)

Burlington Office

Engineer-in-Charge — N.P. Persoage
Secretary — Mrs. E.M. Kerr
Engineers — W.M. Jones, D.W. Brown, P.P. Yee, C.W. Cheng
Technical and Support Staff — R.J. Lloyd, Mrs. C.J. Ferry, Mrs. J.M. Silk

Cornwall Office

Engineer-in-Charge — D.F. Witherspoon
Secretary — Mrs. S.A. Lowe
Assistant Engineer — J.R. Robinson
Technical and Support Staff — R.J. Young, E.G. Allen, Mrs. A.L. David

Niagara Falls Office

Technical Staff — V.J.M. Johns

WATER QUALITY BRANCH, ONTARIO REGION

Chief — W.J. Traversy
Secretary — Mrs. V. Walker

Analytical Services Section

Head — F.J. Philbert
Ship Support Laboratory — O. Elkei
Inorganic Analysis — D. P. Sturtevant
Organic Analysis — R. C. J. Sampson
Support Staff — H. Alkema, N.C. Arafat, K.D. Austen, L. Babjak, D.T. Bennie, W.D. Blythe, P.D. Bothwell, A.D. Bobrowski, J. Gamble, S. Hicks, G. Jamro, J.R. Leacock, K. Li, R. Luft, D. Marsh, R.C. McRea, P.W. McDermott, M.J. Pacenza, G.M. Paquette, J. Patterson, B. Saly, D.B. Sergeant, Y.M. Sheikh, M. Smith, K.A. Terry, H.H. Tse, E. Tuk, I. Valdmanis, J. Verlinden, R.W. Wales, R.J. Wilkinson

Special Services Section

Head — A. S. Y. Chau
Quality Control — D. McGirr, J. Carron
Method Development — K. Aspila
Chemists — H. Agemian, J. Coburn

Monitoring and Surveys Section

Head — M.T. Shiomi
Support Staff — K.W. Kuntz, C.H. Chan

WATER SURVEY OF CANADA

A/District Engineer — M.H. Quast
Secretary — Miss M.R. Milson
Assistant District Engineer — M.H. Quast
Administrative Officer — R. Mertens
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Network Planning and Forecasting — J.E. Slater

Special Studies and Services — B.D. Poyser
Support Staff — R.A. Rees

Niagara River Board of Control — W.M. Archer

Field Operation Section

Southern Ontario — Area Engineer — W.M. Archer (Acting
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Data Review — Engineer — Vacant
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Mrs. F.C. Howitt
Hydrometric Data — Mrs. V.L. Smith
Mrs. D.M. Lucchetta

Construction Section

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Support Staff — L.W. Campbell, K.D. Munn

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Miss K. Mikoda (Acting)

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Secretary — Mrs. R.L. Veerdonk (left August)
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Biological Processes Unit — Dr. B.E. Jank
Chemical Processes Unit — Vacant
Soil Processes Unit — Dr. V.K. Chawla

Special Projects Manager — R.E. Mills

Senior Process Development Engineer — J. McKay

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Head — K. Conn

cilities Services Section

ead — A.D. Stephenson (Acting)

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W.E. Stepko
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D. Plummer
Dr. W.H. Schroeder
S. Metikosh

dministration

dministrative Officer — J. Dobson
PS Accounts — Mrs. G. Mulvaney (Acting)
ores — D.M. Niles

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Mrs. S. Lawson
Mrs. M. Wilson
Mrs. J. Tonaj
Miss B.J. Pinkerton
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P.A. Van Hardeveld
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Typist — Mrs. K. Celeste
dministrative Officer — Miss. I.I. O'Connor
ogram Coordinator — Mr. D.J. Williams

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Dr. M. Munawar — phytoplankton
Dr. D.G. Cook — benthos
Mr. J.B. Wilson — zooplankton
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Dr. P.T.S. Wong — algae, bacteria
Dr. P.V. Hodson — fish
Dr. D.G.S. Wright — invertebrates
Dr. M. MacKinnon — ATP lakes (PDF)
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Dr. J.R.M. Kelso — fish ecology and production
Dr. J.M. Cooley — zooplankton ecology and production
Mr. R. Love — macrophyte production
Mr. J.E. Moore — primary production
Mr. J.K. Leslie — electronic techniques
Dr. C.K. Minns — systems ecology
Technical Staff — R.J. Collins, W.H. Hyatt, M.M. Psutka, G. Dunlop, C. Charlton, K. Roslyn

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OCEAN AND AQUATIC AFFAIRS

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Secretary — Mrs. R. Mikoda

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Secretary — Mrs. R. Andrew
Assistant Regional Hydrographer — E. Brown
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Hydrographers In Charge of Field Surveys

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G. Goldsteen — Revisory I
J. Kean — Spring Control
J. Statham — Resivory II
E. Thompson — St. Lawrence River
G.E. Wade — Lake Winnipeg

J. Wilson — Arctic Surveys
B.M. Wright — St. Lawrence-Chesterfield Inlet

Hydrographers

R. Ball	D. Livingstone
R. Beri	G. Macdonald
M. Casey	J. McCarthy
R. Chapeskie	J.R. MacDougall
J.V. Crowley	R. Mahaffy
K. Daechsel	J. Medendorp
P. Davies	B. Power
B. Eidsforth	D. Pugh
G. Fenn	W.H. Pulkkinen
C. Gorski	R. Rehbein
K. Hipkin	P. Richards
P. Keilland	R. Robitaille
R. Langford	R. Solvason
R. Lasnier	G. Thompson
C. Leadman	J. Weller
R. Lewis	A. Welmers

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Tidal Instrument Development

Head — D. Knudsen
Technical Staff — H. Thurm, J. Kozaczynski

Hydrographic Development

Acting Head — R. Bryant
Technical Staff — R. Tripe, C. Doekes, N. Robinson, M. Crutchlow, P. Millette

Marine Information Centre—Local Surveys

Head — A. Rogers
Technical Staff — E. Gervais, D. Robertson, R. Treciokas

Canada-United States Exchange Program

Canada — J. Kean
United States — Lt. D. Winter

Cartography-Drafting

Head — J. Elliot
Technical Staff — H. Nepomuceno

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Secretary — M. Kimmett

Shore Property Studies Section

Head — W.S. Haras
J.R. Shaw
G. Boyd
S. Haworth

Hydrodynamics Section

A/Head — E.O. Lewis
L. Muir
P. Budgell
S. Baird
D. Robertson
L. Barfoot
V. Leroux

Oceanographic Research Section

Research Scientist — S.J. Prinsenberg
S. Peck
J. Croal
G. Pudsey

Survey Electronics Section

Head — E.O. Lewis
Shop Foreman — W.W. Smith
B. Waldock
G. Kavanaugh
I. Padgett
T. Dyas
D. Pyatt
W. Montgomery
H. Boyce
R. Coons

Environmental Assessment

R.S. Boulden

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Secretary — Mrs. F. Haaka
Engineering Superintendent — A.T. Hughes
Shore Captain — W.S. Corkum
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Shop Staff — H. Ames, J. Fasullo, J. Barrowcliffe, J. Wha

CSS LIMNOS

Master — Captain N.L Keeping
Officers — R. Dean, J.G. Leigh, T.C. Kenney, G. Sproule,
J. Stansfield (11 Ship's Crew)

CSS BAYFIELD

Master — Captain M.C. Birchall
Officers — R. Carson, R.R. Charles (6 Ship's Crew)

CSS ADVENT

Master —Captain I. Williams
Officer — D. Blackwell (2 Ship's Crew)

Launches

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Hydrographic Surveys — 70 Seasonal Ship's Crew

ADMINISTRATION DIVISION

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Secretary — Miss J. Major

Accounts — F.D. Gelinas
Administrative Services — J.C. Stewart
Procurement and Stores — E.R. Gibbons
Transportation — C.J. Fulton
Support Staff — J.G. Rothwell, B. Day, J. Mellon, P. Furlong, R. Goodman, Mrs. K. Allen, Mrs. A. Thompson, Mrs. G. Mulvaney, Miss J. Anderson

Appendix B • Publications and Presentations

Publications and Presentations

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Cover Photography and Art by John Bodnaruk

CANADA CENTRE FOR INLAND WATERS BRANCH

Annual Report

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CCIW Branch
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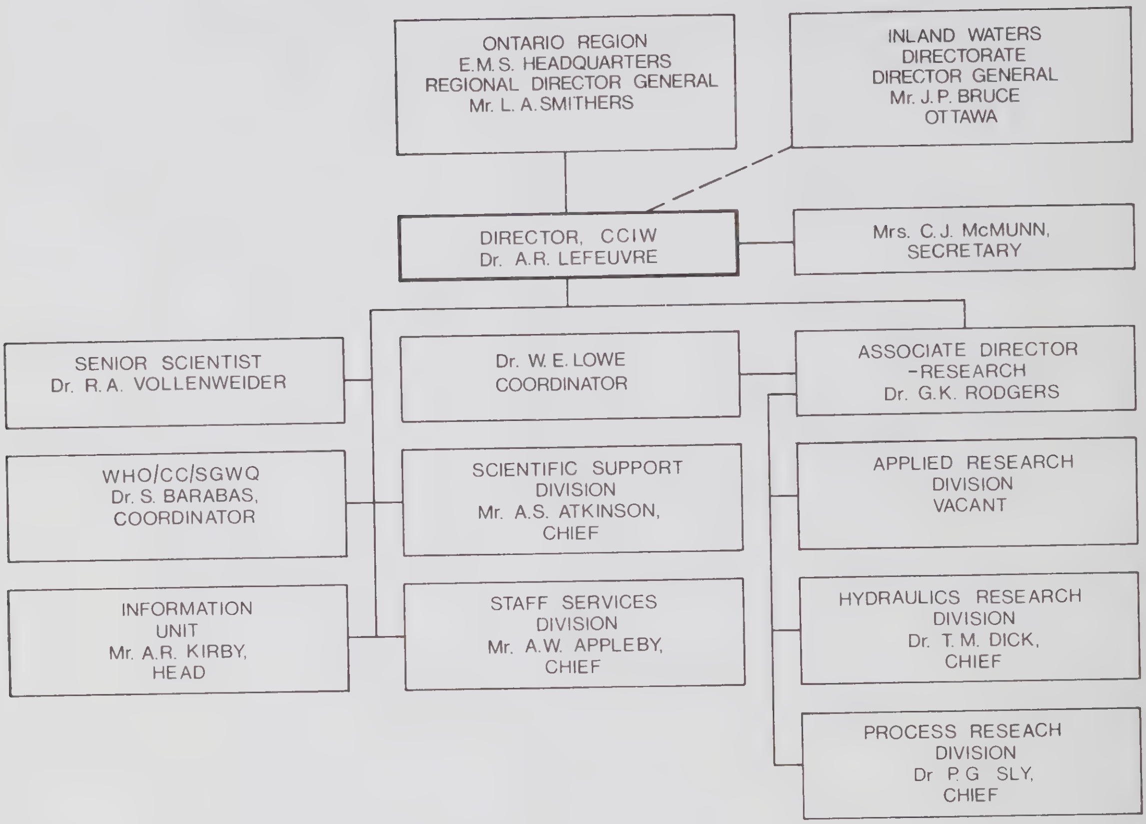

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PREAMBLE

The CCIW Branch of the Inland Waters Directorate is responsible for carrying out research related to the scientific requirements of the Directorate, from coast to coast. This National Research Program focuses on an increased understanding of the chemical, physical, and biological processes which take place within or act upon the inland waters of Canada. This study of system and processes is applicable to many regions of Canada and often is of world wide interest. Each region, however, has particular problems which require site-specific studies and unique research investigations. The research program of the Branch seeks to address these unique problems by mounting relevant in-house research studies and by participating with the Regions and the Branch units located in the Regions in on-site investigations. Examples of current site-specific studies include the Kootenay Lake and Qu'Appelle studies in western Canada, the continuing major involvement with studies on the Great Lakes in Ontario, hydraulics model studies related to the Richelieu River in Quebec, and participation in the Schubenacadie studies in the Maritimes.

The scientists in the Branch are frequently diverted from their primary role of research to provide expert scientific and technical input into policy development on behalf of the Directorate, the Service, and the Department. Scientists from CCIW Branch participate in many policy-level committees, e.g. Environmental Contaminants Act Advisory Committee, Long Range Transport of Atmospheric Pollutants, Radioactivity.

The Canada/US Great Lakes Water Quality Agreement has brought into being boards, reference groups, study groups, committees, and task forces. Many scientists and research managers of the Branch play an active role in these groups. This involvement reflects the major contributions that CCIW Branch continues to make towards the study of and protection of the Great Lakes as a major national and international resource.

CCIW has provided world wide leadership in several scientific areas through a number of international organizations. As the World Health Organization Collaboration Centre (WHO-CC) for ground and surface water quality, CCIW provides leadership, training and major data handling facilities for the water quality portion of the Global Environmental Monitoring System (GEMS). The WHO-CC coordinator, Dr. S. Barabas, has conducted exploratory visits to most areas of the world in order to assess the needs and potential for WHO activities, especially in the developing nations.

The Senior Scientist, Dr. R. A. Vollenweider, continues to provide leadership to the eutrophication studies of OECD and in the coming year will oversee the preparation of the final reports on this international program.

1976 was a year of program and managem realignment for CCIW Branch. The position of Associ Director for Research Programs was established to provid stronger focus on this area of the overall activities of Branch. Dr. G. K. Rodgers, formerly Chief of the Appl Research Division, was appointed as the first Associate Dir tor for the Branch.

A considerable effort was directed to the review the research projects which comprise the research program the Branch. A project set was structured and documented sc to provide guidance to the research scientists in the devel ment of specific research studies and to facilitate the descr tion of the research program in reporting to the Service Department.

CCIW Branch has the major additional responsibi of providing physical facilities and major common sup services, both administrative and scientific/technical, for various elements of the Department which are located toge at the Canada Centre for Inland Waters. The cost of provi the physical facilities has been escalating rapidly in re years due to inflationary pressures on basic goods and servi These increasing costs have been met by special re-allocat of resources from within the EMS and by a concerted effor the Building Manager to reduce fuel costs through conserva measures. A review of this activity by HQ staff documents highly efficient way in which the physical facilities are b managed and commends the staff for its efforts. Common scientific support continues to be provided to all tenants in areas as computer hardware, library, major stores, enginee services, and technical operations. Activities affecting various programs located at the Centre are coordinated b Executive Committee, composed of the Program Direc Subcommittees deal with ship scheduling, library, com support, and program coordination.

CCIW Branch, in its various roles as researc scientific advisor, and provider of physical and scien support, continues to play a leading role in support of Department. The totality of research and survey activi which comprise the complete establishment known as Canada Centre for Inland Waters, serves the Departmen Fisheries & Environment well and will continue to do so as Directors of the programs located at this site maintain focu the overall goals of the Department and the ways in which individual programs, while collaborating and sharing facil on site, work cooperatively towards these ends.

PROJECT LIST FOR CCIW

1976-1977 Fiscal Year

The research program of the Branch was focussed on ollowing topics:

ɔphication — Water quality management for stewardship, food, and recreation requires that water trophic state and nutrient levels be consistent with water use requirements; research is designed to show most suitable methods in resolving water use conflicts, and restoring degraded systems.

: Substances

The presence of deleterious contaminants in the aqueous environment presents both a short and long term water management concern, particularly in relation to food, stewardship, and recreation; and relates to the role of water as both a receiver and as a resource.

Systems — Lakes, particularly large lakes, provide food; and provide water supply for both industry and the human consumption; and serve as a recreational resource.

ıent/Water Interactions

Definition of sediment/water interactions are a prerequisite in establishing the significance of water quality conditions. As such, this research in support of water quality is reflected particularly in management practices associated with aquatic resource use for food, stewardship, and recreation.

ıt Events and Trends

The development of management strategies for medium and long term water use activities is strongly predicated upon assessment of likely future conditions or events. This research is designed to extend the pre-record data base so that more valid judgements may be made ... as the basis of water management practices. Principal social issues relate to settlement, food, and stewardship.

ı Water Resources

Management of urban water resources provides against pollution of water courses and reduces flood damage. The program was initiated because of the term of reference in the Great Lakes Water Quality Agreement.

ɔds Research and Instrumentation

Most of the application of the technology developed in this program relates to water quality as it concerns water supply for human consumption and industry, wildlife, fish, and human recreation.

Commissioned Studies

These studies are usually commissioned to assist in the solution of priority Directorate and Departmental problems. Examples include Mercury, PCB's, and Asbestos as well as contributions to longer term activities such as Point Pelee for Parks Canada, Kootenay Lake in B. C., etc.

Ice and Water Interactions

Ice hinders water flow and causes floods. Ice forces also affect transportation and power production.

Physical Processes in Lakes

Basic knowledge of the physical processes in lakes is essential for understanding the movement and distribution of pollutants and the dispersal of wastes and heat. Surges and seiches cause flooding.

Shore Processes

Industrial activity, recreation, and energy development cause shoreline changes and conflicting activities. Erosion protection is expensive and good stewardship requires conservation of resources. The environmental impact of changes requires the development of models to provide assessment within the acceptable time frame for projects.

River Processes

Rivers provide water for recreation, industry, energy production, and irrigation.

National Calibration

Data collection and research often depend on reliable current speed measurements. Calibration and adjustment of instruments are essential steps.

Research Support

Services included within this category are CCIW site-wide common user services such as the computer and its operation, the library, radioactivity, and electron microscopy facilities and other specialized facilities.

INTRODUCTION

The CCIW Branch of the Inland Waters Directorate, Department of Fisheries and the Environment, responds primarily to the research objectives of the IWD:

> "To provide the necessary information on and understanding of water systems for short and long-term management problems and opportunities in Canada".

The Branch undertakes a national research program in water quality and quantity. It advances, applies, and disseminates scientific and engineering knowledge and understanding of all aspects of inland waters for the benefit of planners, engineers, and managers of such resources throughout Canada.

The core research program maintains and develops the necessary expertise and knowledge to apply the results of research to:

- the development of national effluent regulations, and guidelines
- the development of national effluents, regulations, and guidelines
- the control of the formulation of products that find their way into aquatic ecosystems
- the execution of joint, cost-shared comprehensive basin studies or site-specific investigations (e.g. federal/provincial; Canada/US)
- the provision of advice and assessment tools (models) for the Environmental Assessment and Review Process
- the integration and translation of interdisciplinary understanding into pertinent policy advice.

The research and development programs of the Centre are primarily involved with the quality of Canadian inland waters (rivers, lakes and their basins) and some aspects of the quantity of water, particularly those quantity aspects that relate to the interpretation of water quality conditions, and those that relate to research in hydraulics.

To ensure CCIW Branch research response to b Regional and National problems, research orientation is prov ed from within the Branch by the CCIW Research Advis Committee (comprised of the Senior Scientist, Research Management staff) and from outside the Branch by the I Director General (with advice from the Research Advis Committee which is comprised of IWD Research Advisors other IWD Directors from across Canada). There are for supplements to interactions between CCIW and other Direct ates of EMS, other services, other Departments, and provin governments.

Within the Directorate, the CCIW Branch cooper with the National Hydrological Research Institute (NHRI) also with three operational branches dealing with water qua (networks and laboratories), water quantity (river flows) water planning and management) dyking, flow negotiation, e Within the Service, the CCIW Branch is allied with La Forests, and Wildlife Directorates. Within the Department, through interdepartmental relations, there are links with mospheric Environment Service, Ocean & Aquatic Scien Environmental Protection Service, and National Health Welfare. Ongoing activities also result in relationships proponents of federal projects, such as the Departmen Public Works, Atomic Energy of Canada Limited, and oth Through federal/provincial agreements and the IJC (Cana US), the CCIW Branch becomes engaged upon studies environmental agencies where there are shared jurisdict such as the Great Lakes and interprovincial rivers and lakes

This report describes the scientific activities of staff of the three research divisions: Process Rese Division, Applied Research Division, and Hydraulics Rese Division. The engineering and support activities of Scientific Support Division and the Staff Services Division also reported.

In response to research needs identified outsid Ontario Region, the Branch has detachments in Vanco (Pacific and Yukon Region) and at the Freshwater Institu Winnipeg (Western and Northern Region) engaged primari site-specific or regionally relevant research topics.

WHO COLLABORATING CENTRE ON SURFACE AND GROUND WATER QUALITY

'RODUCTION

In October 1974, the Canada Centre for Inland ters (CCIW) was designated by the World Health Organiza- 1 (WHO) as the WHO Collaborating Centre on Surface and und Water Quality (CC/SGWQ). Such international centres designated by WHO to assist in the development and ntenance of high standards of work in specialized fields, and :oordinate certain international activities in order to achieve roved precision, reliability, consistency and comparability in ctice and better results from national and international lies.

The designation of CCIW as the WHO/CC was made ecognition of:

- the expertise of the CCIW scientific staff in water quality management;
- the extensive laboratory facilities available at CCIW, and,
- the expectation that such expertise and facilities might be made available from time to time to technologists, engineers, and scientists of other countries, particularly developing countries, for advice and/or training as required and mutually convenient.

MS OF REFERENCE

The original terms of reference in establishing the)/CC comprised the following activities:

- production of a bi-monthly or quarterly newsletter on water quality progress;
- dissemination of information on standard measurement and assessment methods;
- assistance on planning and execution of projects on international water bodies;
- development of training programs;
- providing answers to requests for technical information.

This program was subsequently expanded to include development and operational management of a "global r quality monitoring" system.

IVITIES IN 1976

During the year under review, WHO/CC had carried he following activities:

Initiated regular quarterly publication of the Water Quality Bulletin - Bulletin de la Qualité des Eaux, in separate English and French editions for international distribution. The Bulletin is devoted to reviews of water management practices of international significance by nationally and internationally renowned scientists and managers. Approximately 1200 copies in English and 500 copies in French are printed of each issue. The Bulletin is distributed free-of-charge to a growing number of subscribers located in over 80 countries on the five continents of the world. Direct mailing from WHO/CC goes to some 600 addressees; additional mailing is made out of Geneva, Lima (Peru), and some other countries. In the four issues published in 1976, a total of 38 articles appeared written by scientists from 11 countries on four continents: Argentina, Australia, Brazil, Canada, Hungary, Japan, Mexico, New Zealand, Peru, Philippines, Polland, USSR, and Yugoslavia.

(2) Coordinated the preparation of, and/or made a major contribution to the preparation of international "guides" and "manuals", such as:
  - A Guide on Water Quality Management (second draft)
  - A Guide on Water Quality Surveys (in press), and
  - Monograph on Diffusion, Dispersion and Self-Purification Processes of Pollutants in Rivers, Lakes, Reservoirs and Estuaries (first draft).

(3) Conducted regional surveys of the Western Pacific, Latin America, Eastern Europe, and Southeast Asia, for the purpose of assessing the state-of-the-art in water management practices, identifying the available expertise, determining the needs, and securing the cooperation of the countries involved.

(4) Responded to the findings of such surveys and international inquiries by:
  - providing manuals on sampling, analytical methodology, microbiology, data and documentation storage and retrieval systems;
  - arranging short-term consultancies and visiting fellowships on behalf of such organizations as CETESB, Sao Paulo, Brazil; FEEMA, Rio de Janeiro, Brazil; Secretaria de Recursos Hidraulicos, Mexico City, Mexico; CARIS, Buenos Aires, Argentina; INCYTH, Buenos Aires, Argentina; Laguna Lake Development Authority, Manila, Philippines.
  - answering technical inquiries and conducting literature search, and
  - donating technical journals and books and providing on "indefinite loan" laboratory equipment as required and available.

(5) Played an active role in the preparation and/or conduct of a number of international symposia, such as International Symposium on Interaction Between Water and Living Matter, Odessa, USSR: and ECE Committee on the Protection of Coastal Waters Against Pollution from Land-Based Sources, Lisbon, Portugal.

PUBLIC INFORMATION UNIT

The CCIW Public Information Unit continued to focus its modest resources on two important endeavours - response to public requests for information and media relations.

During the year, over 2000 separate requests were handled in the Information Service. Although usually related to water management problems or to papers and reports, the range of enquiries extended from questions about fish toxicity to dynamiting tree stumps.

Despite the three-year old cancellation of the public visits program, as an economy measure, scores of applications to visit or tour the Centre continued to be received.

By far the year's major news story was Dr. Dickson Liu's breakthrough in bacterial degradation of PCB's which resulted in extensive national and international attention. While the Centre's recently completed film explaining its work, "Second Frontier", continued to be both borrowed for private screenings and publicly telecast (including two broadcasts over the complete Global TV network), television, radio, and newspapers maintained a steady interest in relating CCIW's efforts to Canada at large. The CBC broadcast two separate television features during the autumn as well as radio interviews of various staff members. CTV interviewed the Director on the health of the Great Lakes as also did the Toronto Star, Global TV News, and the Burlington Gazette.

Among the most popular radio programs on wh staff from the Centre were interviewed and its work discus were: "The Rogers Report" (CBC), "The Betty Kennedy Sh (CFRB), "As It Happens" (CBC) and, "The Bruce Smith Sh (CBC).

Levels of the Great Lakes continued to interest media in response to monthly news releases reporting current and predicted conditions half a year hence.

Further media interest in the Centre was occasic by the August visit of The Honourable Russell Train, Admir rator of the U.S. Environmental Protection Agency, accom ied by The Honourable Mitchell Sharp, The Honourable Ge Kerr, Ontario Minister of the Environment, and Mr. W Giles, Assistant Deputy Minister of the Ontario Ministr Natural Resources. Similarly, several months later, the Annual Hydrographic Conference provided further opport for reportage and interviews.

A new aspect of the Unit's activities was i governmental cooperation with the Ontario Ministrie Environment and Natural Resources to produce shared prog of public information relevant to joint activities such a Canada-Ontario Agreement on Great Lakes Water Quality the Canada-Ontario Great Lakes Shore Damage Survey.

Distinguished guests during 1976 included, (seated left to right) the Honourable George Kerr, Minister of the Environment, Government of Ontario, the Honourable Russell Train, Administrator of the United States Environmental Protection Agency, the Honourable Mitchell Sharp, President of the Privy Council, and Mr. Walter Giles, Assistant Deputy Minister of the Ontario Ministry of Natural Resources, seen here at a news conference arranged as a finale of their visit to the Centre.

PROCESS RESEARCH DIVISION

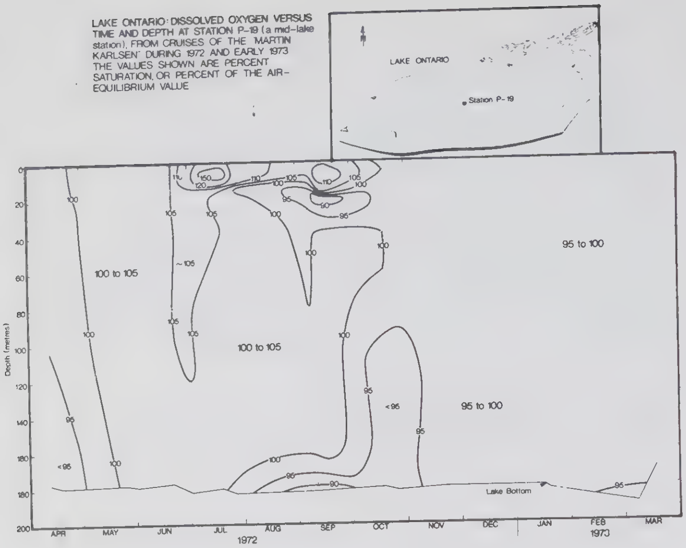


Figure 1 Dissolved Oxygen in Lake Ontario

BOTTOM GAS SAMPLER

1. Polyethylene sample bottle, 1ℓ capacity
2. Stainless steel cone (304 ss), dia. 23.02" h. 13.25"

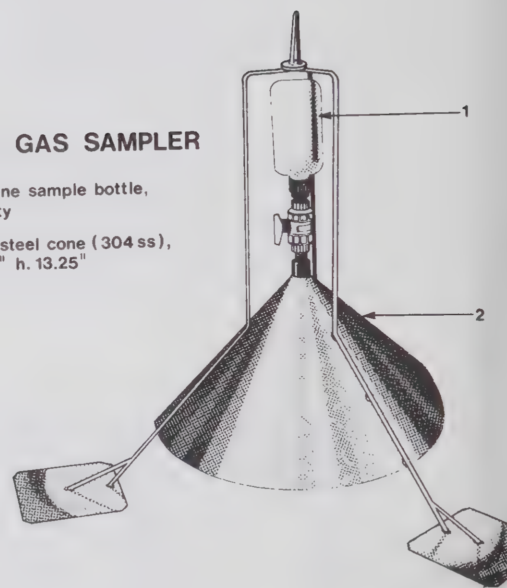


Figure 3 A bottom gas sampler.

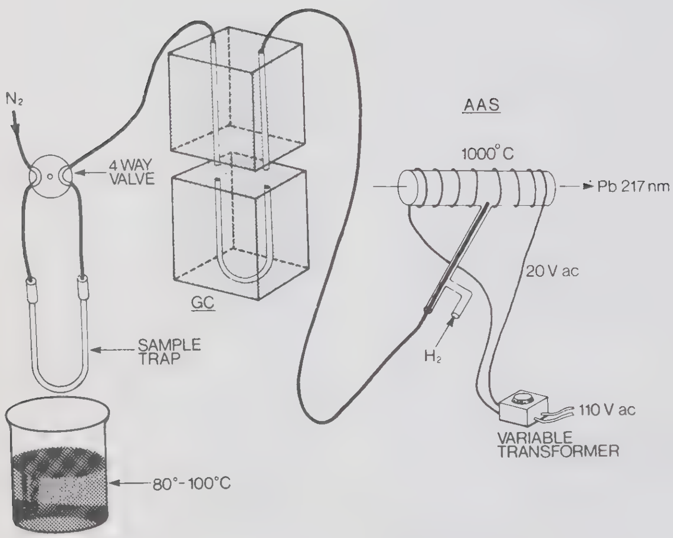


Figure 2 A GC-AAS system for element- and speciation-specific analysis of volatile organometallic compounds (detection limits 0.1 ng as the element).

For the discussion of these figures see pag

TRODUCTION

The Process Research Division contains five :tions: Nutrient Dynamics, Toxic Substances, Water Chemis- ', Geology, and Paleoenvironmental Studies. Projects under idy include Eutrophication, Toxic Substances, Urban Water sources, Sediment/Water Interaction, Recent Events and ends, and Methods Research and Instrumentation Commis- ned Studies.

The Division remains closely involved in a wide ige of studies and associations with other Canadian federal encies, provincial agencies, US agencies, and universities anadian, US and overseas). Particular emphasis has been iced upon close coordination with the IWD support programs :h Canadian universities through the IWD Office of Subven- ns in Ottawa.

Research is strongly focussed upon problems and icerns in the field of water management, across Canada, and ny of the Division's staff are actively involved in advisory l consultative capacities on a variety of committees and dies.

The Division has strongly supported the work of the : references on the Upper Great Lakes, on pollution from d use activities, on dredging in the Great Lakes, and is rently addressing contributions which may be made to dies on long range transport of air pollutants. Particular ention has continued to focus on problems associated with ic substances in aqueous systems, and Division staff have de substantial contributions with regard to heavy metals in environment, persistent organics and oil spill effects.

In the light of forthcoming considerations relating to Canada-US Agreement on Great Lakes Water Quality, many ivities continue to focus on problems of nutrient control in e systems and prediction of response under various manipula- e practices.

TROPHICATION

Trophic Conditions

Eutrophication research addresses, in particular, need for effective water quality standards associated with ient loadings and the character of biological response. The owing questions illustrate some of the scope of this National arch area:

> What forms of response to cultural loadings are exhibited by various surface water systems; what levels of loading will still permit acceptable water quality; in terms of multiple water use, what objectives and criteria may be appropriate and how should such assessment be formulated; what options are available when considering loadings ..... can "cultural" inputs be put to good use or must we continue to view them only in the light of some form of "effluent control"; how do nutrient loadings become reflected in biological response; what do we know of such stressed systems and the synergistic effects of toxic material in this environment; how can we develop suitable systems models of a quantitative nature to allow for improved management of resources; how can we distinguish the variability and long term changes in natural water system from the variability and long term changes in natural water systems from those under cultural influence.

The complexity and scope of processes which culminate in Eutrophication require that research studies direct attention at a wide range of lake types, from Oligotrophic to Hyper-Eutrophic; within this context research has included studies on both large and small lakes and upon "fjord" lakes (typical of the Pacific & Yukon region), and river-lake systems, as opportunities have arisen in conjunction with CCIW and IWD regional programs. The processes of nutrient availability, algal growth and decomposition, zooplankton grazing and nutrient flux to and from sediments in a wide range of lakes must be better understood if the fundamental characteristics of eutrophic systems are to be appreciated.

During the past year techniques have been applied to systems to quickly demonstrate if phosphate, nitrate or ammonia are controlling algal abundance. These techniques involve radiotracer studies using $^{32}P\text{-}PO_4$ and $^{14}C\text{-}HCO_3$ plus stable isotopes $^{15}N\text{-}NO_3$ and NH_4. Emission spectrophotometry has facilitated the more comprehensive nitrogen metabolism studies. Work has also progressed on the use of acetylene reduction techniques to estimate the importance of N_2 -fixation in the supply of nitrogen to lakes.

The interrelationships of light, nutrient uptake, algal growth and decomposition are central to understanding lake metabolism. Traditional methods of measurement of primary productivity have provided a very confusing picture. During the last three years the diurnal O_2 changes in Lakes Ontario, Erie, and St. George have provided a clear demonstration of the inadequacies of the ^{14}C and O_2 bottle methods.

It is always suprising to find that the amount of organic carbon which is "dissolved" in lake waters is 2 - 10 times the particulate organic carbon. This material has now been characterized chemically and its role as nutrient and metal carrier demonstrated. Transmission electron microscopy has been used to document the micromorphology of the fibrillar colloids and to establish sites for extra-cellular phosphatase activity.

Vertical fluxes of nutrients and factors which influence nutrient fluxes from sediments continue to represent an important aspect of eutrophication research. Techniques employed to measure vertical flux include settling chambers, sediment traps, and mass balances. It is hoped that ultimately settling rates can be related to hypolimnetic O_2 depletion rates and release of nutrients from sediments. Internal loading of nutrients has been detected using substance budgets and the reduction of iron compounds in the sediments has been measured, using Mossbauer techniques.

Trophic Conditions and Dissolved Oxygen in the Great Lakes

In 1976, an extensive internal report was prepared entitled "Eutrophication status of the Great Lakes". This report is presently under consideration by the Nutrients Task Group of the Water Quality Objectives Subcommittee, IJC, and two shorter papers have been derived from it.

The first of these, "A Trophic Scale for the Great Lakes" has been submitted to the Journal of the Fisheries Research Board. A second, "Trophic Conditions in the Great Lakes, 1968 to 1975, on the Onset of Trophic Management", is in preparation for the 1977 Great Lakes Conference and for the Journal of Great Lakes Research. This research deals with summertime mean values of Secchi-depth, chlorophyll, particulate organic carbon and total phosphorus, in offshore near-surface waters.

From June 1976, a study has proceeded involving interpretation of Great Lakes dissolved oxygen data. Interpretation for Lake Superior, Lake Huron, and Georgian Bay has been completed. Lake Ontario is currently under study, to be followed by eastern and central Lake Erie. Data included those of CCIW, 1966 to 1976, plus earlier data for Lake Erie. The work is viewed as background knowledge for Great Lakes water quality management. (Figure 1). (See page 10)

TOXIC SUBSTANCES

The CCIW national research program on toxic substances complements the work of a number of other Canadian and US federal agencies and provincial agencies and in particular the need for more effective water quality standards provides a particular focus of attention. CCIW-IWD research is directed towards the development of methods and analysis for identification of contaminants and characterization of their form; to an assessment of their distribution, persistence, pathway, bio-accumulation, and possible degradation in the aquatic environment; to an understanding of their synergistic effect in aquatic stress, and in particular to an understanding of their significance as an inhibitor within nutrient dynamic processes.

Becase many agencies are presently involved with Toxic Substances research, IWD-CCIW is trying to build not only upon the results of its own studies but, particularly, to complement the work of others. Whilst this provides for optimal use of resources, it also has the effect of fractionating the overall study into a number of specialized activities which relate not so much to each other, individually, but to the sum total of the national (and international) research effort.

Metals and Organometals

Further experiments carried out this year indicated that chemical methylators, such as creatinine, methionine, cobalamine, etc., which successfully methylate mercury, do not methylate lead (Pb^{2+}). Methylation may follow a mechanism proposed by Carty for mercury - a non-B_{12} mechanism - which involves the formation of a homocysteine complex.

Lake sediment cultures, as well as pure bacterial cultures without sediment, have been found to convert selenite and selenate salts to two, sometimes three, and four volatile selenium compounds, identified as dimethyl selenide, dimethyl diselenide and unknowns.

Sediment samples were collected to test their ability to methylate Pb, Se, As. Time was also spent in the Experimental Lakes Area near Kenora to participate in the lake acidification studies with staff of both the Freshwater Institute at Winnipeg and the Great Lakes Biological Laboratory (CCIW) where the complexing capacity of the waters, the labile and bound metals, etc.,were measured. Additional activities included:

1) the development of an element- and speciation-specific technique for the analyses of a number of organometallic compounds (Figure 2), and

2) the design of a bottom gas sampler for field collection of sedimentevolved gases (Figure 3).

Further to the study on the toxic forms of lead, an algal bioassay indicated that toxicity of lead is related to the complexing capacity of the medium. This study was conducted with a variety of lake waters of different complexing capacities from the Sudbury region.

Sediment samples were obtained from areas having mercury-rich deposits; namely, Niagara-on-the-Lake, Lake St. Clair, Peninsula Harbour (Marathon, Lake Superior) and in the Wabigoon River system (Dryden). They were examined for release of methyl mercury and for existing levels of mercury (total and methyl) in the related surface waters and sediments. Studies were also undertaken which demonstrated the integrity of procedures for samples frozen in the field and analyzed in the laboratory. As an example, results from studies of l and release of methyl mercury are given in the table below.

	Water	Sediments		
	MeHg (ng/ℓ)	MeHg (μg/kg)	Total (μg/kg)	MeHg Re (% in 3 h
Niagara	<0.7	3.4- 8.5	2900- 3900	0.0
St. Clair	<0.7	<0.1-18.5	108- 2300	0.14-0
Peninsula Harbour	<0.7-1.2	13-40	15700-25700	0.14-5
Wabigoon River	<0.7-3	1.4-14.5	1080- 4500	0.03-1
Hamilton Harbour	< 0.7	0.4- 2.4	750- 3890	0.05-0

Studies on the binding of methyl mercuric hydr to N-formylmethionyl transfer ribonucleic acid of Escher coli were completed and the results presented in a publ paper. The reaction was studied spectrophotometrically indicated that the N-Formylmethionyl-tRNA bound the m mercury firmly and quickly to the 4-thiomidine base in the position from the 5' end of the RNA molecule.

Identifications

Snow and rain samples were collected and ana for PCB's and organochlorine residues. The snow was from sites in the northern Ontario, Ottawa, Kingston Hamilton regions. Rain was collected, on an event basis, seven sites at Sibley (Thunder Bay), Batchawana Bay, God Manitoulin Island, Pelee Island, Picton, and CCIW. Prelim results indicated the presence of lindane, methoxychlor, sulfan, DDT residues, dieldrin, α -BHC, as well as PC quantifiable amounts in most samples.

Samples were also collected and analysed to changes taking place at different times during a rainfall at several selected sites. Such profiles are being corr with data from a sensitive rain gauge and may f characterize the mode of deposition of some of the obs compounds.

An analytical procedure for the determinati volatile halogenated hydrocarbons in water by gas chro graphy at the 1-100 μg/ℓ range was developed and has modified to allow for field application. Employing these t ques, samples were obtained from the Welland River (N Falls), Hamilton Harbour, St. Clair River (Sarnia) and B wana Bay (Lake Superior). The majority of these samples analyzed by simultaneous electron capture (EC) and ionization (FID), and also by simultaneous FIC and photometric (sulfur mode) detection. In many samples, were up to ten chromatographic peaks (EC), most of whic been tentatively identified only. Identification by C analysis has not been successful to date because of the lower sensitivity of this instrument.

Samples related to two particular industria near Niagara Falls and near Sarnia were obtained. sediment and seston samples were extracted; the first b solvent and XAD-2 resin method. All extracts have methylated and a start has been made to analyze them gas chromatograph-mass spectrometer system. These minations, together with data from a study of Twelv Creek, will be assessed as a tool for future regime dis studies.

Degradation

Laboratory conditions were developed for a c ent colorimetric determination of dehydrogenase acti lake sediment by reaction with the dye resazurin. Such a expected to prove useful in characterization of areas

gical activity and hence probably of degradation of organic ances. Excellent precision (better than ±3%) can be ned at sensitive levels (capable of detecting 1×10^6 rial activity in 30 min) which correspond favourably with tests for biological activity. Preliminary results were nted at the 19th Great Lakes Conference. Since then, fications have been made on the test to improve its ficity. In cooperation with Dr. Tobin (ARD), the method een tested on sediment samples from Lake Erie and a good lation between this resazurin test and their ATP test was ved. Further testing on environmental samples is being taken.

Experiments have been conducted to study the toxic t of 3-trifluoromethyl-4-nitrophenols (TFM) on the micro-nisms in lake sediment. It was found that TFM at entrations of 20 ppm or less (TFM is applied less than 15 in the field) caused no significant changes in either ers or types of heterotrophic bacterial populations. The llation of four cyclone fermenters in late 1976 greatly ded up the persistence study of TFM. A degradation study natural, exposed sediments gave evidence of two metabo- of TFM under anaerobic degradation conditions. One of is 3-trifluoromethyl-4-aminophenol (RTFM). The experi- is being repeated for confirmation purposes. An experi-al model ecosystem study (in conjunction with GLBL) has started, involving simulation of actual stream treatment TFM under controlled conditions.

From studies with a potent PCB-degrading bacter- solated from activated sludge, a theory was developed to eate the degradation mechanism of persistent organic ances in the aquatic environment. Studies showed that the ry site of the biodegradation of the persistent compounds the substance-water interface, and that the rate of such gradation can be greatly increased if the test compound e suspended in the aqueous phase as a fine stable emulsion. ing for a bench scale experiment on the study of PCB's gradation, using these principles has been completed.

Behaviour

Two streams and their receiving waters were studied e and after treatment with the lampricide, 3-trifluoro-yl-4-nitrophenol (TFM). Water and sediment samples were cted and examined by GC and GC-MS for TFM and possible olites. Samples from Oakville Creek (Lake Ontario) have analyzed and, although the data are not yet fully ssed, there is definitely some low-level persistence in both and sediment at the ppb level. The Sable River (Lake ior) samples have not yet been analyzed.

The mechanisms by which cellulose is degraded in al waters are not well understood and are of significant onmental importance. The cellulase enzymes of the mold oderma viride were purified and the mechanisms of their ion with insoluble cellulose were examined. The celluloy-nzyme β-1, 4-glucan cellobiohydrolase is responsible for plitting of cellobiose (glucose dimers) from cellulose and ellobiase hydrolyzes cellobiose to glucose. The kinetics of ction of these two enzymes were examined in detail as a ion of various physical and chemical variables; various res of their mechanisms were elucidated.

Research was begun on the distribution of pesticides heir partitioning between the aqueous and sediment phases ural systems, and the fate of the pesticide in each phase. esticides to be examined are those used for the control of pruce budworm in New Brunswick, fenitrothion [0,0-hyl-0-(4-nitro-m-tolyl) phosphorothioate], and matacil imethylamino)-3-tolyl-N-methylcarbamate]. A literature igation has been completed and a beginning made on the ical aspects of this problem.

Oil

A study with a laboratory microbiological model, state bioassay system previously developed showed it can be used in biological work. Several static assays, using Lake Ontario water, indicated that 1-15 ppm of the dissolved volatile gasoline fractions stimulated the growth of natural heterotrophic bacteria in the water. A flow-through bioassay system, adapted from the static system, was also developed which produced steady state concentrations of 1-2 ppm of dissolved volatile gasoline components in an aerated system.

Work is currently underway on the identification of the dissolved volatile oil components in the above systems. Preliminary results indicate a mixture of 15-20 hydrocarbons, 80% or more of which are aromatics, predominantly benzene, toluene, and xylenes.

A Workshop, entitled Impact of Oil in the Freshwater Environment: Canadian Research Priorities, was held at CCIW in October; it is anticipated that the proceedings (available April 1977) will provide considerable guidance for future work in the broad field of oil and the environment. The major areas of research which were identified as having high priorities, include dispersant effects, community effects of oil spills, statistical assessment of recorded spills and behaviour of oil under ice conditions.

The cleanup of the ecosystem ponds at Shirley Bay, Ontario, was completed satisfactorily. The assessment of the results on the response of these systems to an imposed stress, oil, applied during winter conditions, has progressed slowly. It was found that the more oil used, the greater the shift of the biological system from that found in the control pond. When similar amounts of oil from different sources were applied, the systems responded in different ways. When Pembina cruide oil was used, protazoa dominated the microbiota but in ponds where Normal Wells oil was utilized, chlorophyta generally was the dominant phylum. Chlorophyta also dominated in the control pond but the timing of the blooms was quite different from those of the heavily oiled ponds.

No major differences in either the microbiota or zooplankton were observed between oil treated and control ponds, while there was complete ice cover. However, once the ice cover melted, the differences above, both in phyla and populations, were observed. A draft report of these results has been prepared and will be completed during 1977.

URBAN WATER RESOURCES

Some of the major effects of growing urbanization are the increased pollution of both potable water supplies and receiving water bodies. The main objectives of research under this program are to provide information concerning the characteristics of urban water supplies and their significance in terms of local water treatment (e.g. organics content, fibres content), and to assess the effects of various water treatment processes on potable supplies and effluents, and their impact on receiving waters (lakes, rivers, streams etc).

National Assessment of Inland Waters

Searches of existing data files were carried out to gather information for a national inventory of natural organic compounds in inland waters. All Provincial Departments of the Environment have been contacted for information as have numerous universities and the NAQUADAT system.

Parameters searched for included: humic acid, fulvic acid, lignin, tannin, phenols, chlorophyll a, resin acids, amino exposed carbon: the actual adsorption process is relatively efficient (70-90%). EPA scientists now agree with us that the system has severe limitations.

A seasonal survey of four water treatment plants has been carried out with the CAM but only gross changes in organic loadings could be detected. Analysis of some of the extracts from this survey have resulted in the identification of numerous individual organic compounds humic acids, fatty acids (C_9-C_{22}), phthalate esters, etc.

SEDIMENT/WATER INTERACTION

As with other areas of research CCIW sediment/-water interaction studies are national in scope and complement the work of other federal and provincial agencies in respect to the development of more effective water quality standards and methods for basin management.

Objectives are as follows: to determine the character and distribution of sediments in rivers and streams, and compare with source materials to differentiate natural "background" conditions from those related to various forms of cultural loading; to develop an understanding of materials transport, pathway, weathering and in situ degradation processes which affect specific basins under different climatic regime; to assess the chemical-biochemical and geochemical characteristics of selected study areas to define what sediment-/water interface parameters may be used; further, to define the types of processes which prevail in various aquatic environments so that the availability of various contaminants may be determined; to determine bottom loading and suspended load characteristics of individual aquatic systems, and, by comparison with budget models, to characterize lake response in terms of limnological processes, to assess the broader aspects of geochemical cycles in whole watersheds at both local and regional scales.

Weathering of Minerals in Lake Erie Sediments

A project to examine the weathering of minerals in Lake Erie surface sediments is almost completed. The mineralogical composition of sediment from 135 stations has been determined by X-ray diffraction. In addition. the acids, chloroform potential, etc. Data on only a few of these parameters were available at each of the 24 initially selected stations (two in each Province) and, consequently, an extensive experimental study will have to be undertaken during the coming year. It is intended to collect, condense, and tabulate the data and index it in terms of geographical location, individual chemical compounds, classes of compounds, local water chemistry, etc.

Photochemical Processes in Aqueous Systems

Techniques for establishing photochemical reaction mechanisms in simple model systems, such as tertiary alcohols and ethylene glycol, have been developed and two papers on structural and radical reactivity patterns will soon be published in Can. J. Chem. With this groundwork completed, it should be easier to establish photochemical reaction mechanisms for a wider range of environmentally-relevant compounds.

The Effect of Water Chlorination Processes on Naturally-Occurring Materials in Inland Waters

The production of volatile haloforms (mainly chloroform and bromodechloromethane) during water chlorination has been attributed to humic and fulvic acid-like precursors. Since much of the fulvic and humic material in natural waters is associated with suspended matter, the simplest way of reducing the haloform levels in finished water is to remove the suspended matter prior to chlorination. It has been shown that standard water treatment processes, such as alum coagulation and sand filtration before chlorination, effectively reduce the concentration of precursors by up to 66%. Ozone was also demonstrated to be effective in removing haloform precursors.

Organics in Treated and Untreated Potable Waters

In the light of rising concern about various water treatment techniques, studies were directed at the effectiveness of the carbon adsorption minisampler(CAM). A thorough evaluation of the CAM revealed thgt the unit was not as useful as had been predicted by the US Environmental Protection Agency. The limitations of the unit are mainly associated with the high sulfur content of the carbon and extraction of the composition of eight fractions ranging from fine sand to clay-sized material from 12 selected stations has been determined.

These data have been compared to the composition of sou material in the shoreline bluffs. Calcite is highly weathere Lake Erie and is present in only a few stations close to sh and locations where sedimentation rates are high. Dolomit also very depleted in the sediments. There is evidence also feldspars and possibly illite are depleted in the lake sedim relative to the bluff materials. The data are being examine determine rates of weathering and pathways of sedim transport.

Fibres in Lake Superior Sediments

Preliminary examination last year of the f content of 20 Lake Superior surface sediment samples discl the presence of large numbers of asbestiform grain sediments close to Silver Bay, Minnesota, with diminis numbers further out in the lake. This project has continued with fibre counts being made of approximately samples throughout the whole lake and mineralogical anal of fibres from about 50 of these samples. The data wi analyzed to determine the extent of taconite tailings dispe through Lake Superior, and a report is expected to be avail in mid 1977.

Vegetation of a Subarctic James Bay (Ontario) Marsh

Vegetation studies including species composi cover and biomass were made along a one kilometre transe a salt marsh located on the southwestern coast of James near Moosonee, Ontario, Canada. Eight vegetation zones determined from an intertidal colonization area dominate Puccinellia phryganodes to the edge of willow thickets a landward end of the marsh. In each zone, above-ground bio of vascular plants was determined by clipping at the tim peak biomass. Values ranged from a low of 29 g/m^2 weight) on gravel beach ridges and 159 g/m in the mid-m to a high of 569 g/m^2 in the zone nearest the willow th which was dominated by Juncus balticus. A weighted-above-ground biomass for the marsh was 357 g/m^2. biomass values were lower than reported in the literatur salt marshes located on the Atlantic coast of North Ame but were higher than those reported for Swedish salt mar Important parameters influencing species composition biomass include moisture regime, soil salinity, microtopogr and possibly soil temperature, as earliest vegetative, g occurred in the Juncus zone which thawed first.

The most abundant species of salt-marsh veget include Puccinellia phryganodes, P. lucida, Scirpus marit Triglochin maritima, Plantago maritima, Atriplex glabriu A. patula, Glaux maritima, Salicornia europea, Hordeum tum, Potentilla egedii, Carex paleacea, and Juncus balticu

Water Chemistry of Mire Ecosystems in the H Bay Lowlands of Ontario, Canada

Water samples were collected in lakes, fen an pools from the mire ecosystems of the Hudson Bay lowla Northern Ontario, Canada during the summer of 1976. O of 18 different water samples, a total of 33 che parameters were analysed including pH, nutrients (N+P), cations and anions, and trace metals. Waters varied ombrotrophic bog pools, averaging pH 4.0 to a marl lake 8.2. The bog pools were characterized by low concentrati most major ions, including silica, compared to minerot fen and lake waters, while sulfate was higher in bogs. nitrogen and phosphorus status of bog waters was not s cantly lower than more minerotrophic waters. Trace concentrations were similar in all waters studied. In inorganic carbon, measured as total alkalinity and bicarb was extremely low, but dissolved organic carbon was highe particulate organic carbon levels were similar to those fo minerotrophic waters of fens and lakes.

An examination of conductivity of waters area indicated that this parameter does not appear to be r to content of major ions in bog waters after subtr

rogen-ion conductivity. This may be attributed to a uction of major ion conductivity by complexation due to olved organic compounds.

Wetland Studies

Wetlands, including marshes, are an important eco-em in terms of both natural and human interest, and shes are complex hydrologic and biochemical ecosystems in ch various elements may be transformed into compounds may modify existing water quality. A study was initiated nvestigate the structure, functioning and productivity of oral areas in different types of Great Lakes marshes with pect to the release and/or retention of nutrients and heavy als. The results of a preliminary investigation of concentra-s of zinc, lead, cadmium, cobalt, chromium, nickel and per in three marshes on the eastern shore of Lake St. Clair ved the accumulation of these metals in marsh sediment icles and in the marsh plant tissues. However, the metal centrations in the marsh water remained low during the le study period. Consequently, it can be concluded that the low from these marshes will contribute only negligible unts of the metals studied to the Great Lakes water.

Forms and Accumulation of Phosphorus in Lake Erie Sediments

The phosphorus in 48 surficial Lake Erie sediment ples has been found to be in three major forms: phosphorus ciated with apatite, nonapatite inorganic phosphorus IP), and organic phosphorus. The apatite is of natural, ital origin. It exists as particles ranging from fine sand to in size but mostly as silt-sized particles and is concent-d in fine-grained sediments accumulating in offshore depos-ial areas. NAIP is associated with amorphous hydrated c oxide in the oxidized microzone, but is present as nite ($Fe_3(PO_4)_2.8H_2O$) and possibly other forms also in the ced zone. The organic phosphorus content of the sediment osely related to organic carbon content. The phyllosilicate, nic matter, and reactive iron and manganese components of sediments existed in intimate association.

Six Lake Erie sediment cores, from locations having ly different sedimentation rates, show that rate of input sedimentation of apatite phosphorus at a given locality has approximately constant during the last few hundred years ive to total sedimentation rate at the same locality. ite is not a significant source of soluble phosphorus for Erie. By contrast, the rate of sedimentation of nonapatite anic phosphorus (NAIP) and organic phosphorus has steadily ased in accordance with increased loadings in recent years ne source material, namely phosphorus of anthropogenic n. The rate of sedimentation of these two forms of phorus at a given locality varies greatly within the lake, is greatest where the most fine-grained sediments are nulating. It was concluded that the sediments of Lake Erie ain sufficient orthophosphate-retaining sites to prevent r regeneration of phosphate under any conceivable tion, provided the overlying water remains oxidized.

Diagenesis of Organic Matter in Great Lakes Sediment

The organic matter in the modern sediments of Ontario, Erie and Huron is composed of humic compounds o 85%), amino acids (10 to 20%), lipids (2 to 8%), hydrates (2 to 6%) and amino sugars (0.5 to 4%). Amino and carbohydrate concentrations are high in plankton es, which are the primary source of sedimentary organic r in the Great Lakes. These compounds are decomposed their passage through the food chain and at the ent-water interface, with the concurrent formation of compounds. The degree of diagenesis of modern entary organic matter is related both to the trophic state lake and to the water depth, with the greatest degree of tion in the most eutrophic lake basins and in the west water depths. Diagenesis of the organic matter is prior to burial in the sediments and is slow after burial. The decomposition rates of the sedimentary organic matter are in the following order: amino acids > amino sugars ⩾ carbo-hydrates > humic compounds > lipids.

Stable Isotope Studies

Isotope ratio measurements have provided important clues on the sources and sinks of atmospheric sulfur. The isotopic compositions and concentrations of sulfur in bulk precitation samples collected from October 1973 through September 1976 at 37 stations in the Great Lakes Basin have been monitored and the $\delta^{34}S$ results are summarized in Figure 4.

The striking feature of the graph is the marked seasonal variation, with the samples in the winter months being

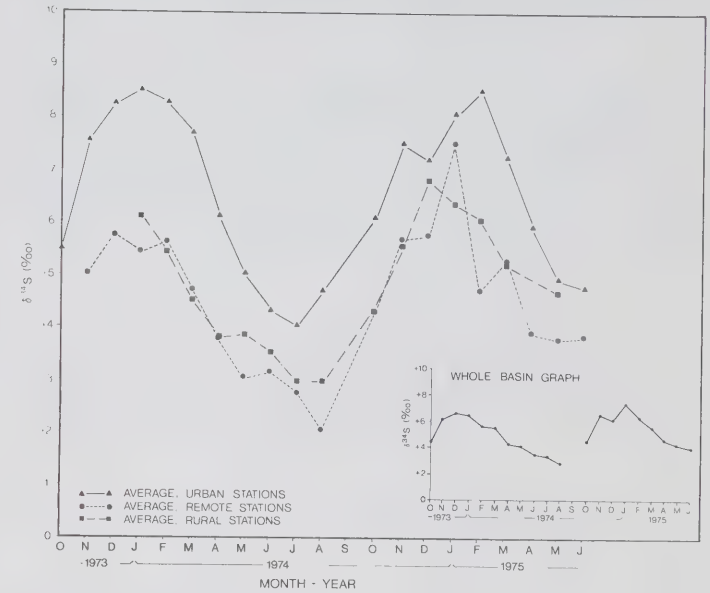


Figure 4 Seasonal Variations of Isotopic Ratios in Atmospheric Precipitation

much heavier than those of the summer months. For all the stations, the mean difference in sulfur isotopic composition between the winter and summer months is about $4^{o}/oo$. The difference between the data for the urban and rural/remote stations is also quite pronounced. In contrast to the isotopic data, there were no seasonal variations in sulfate concentra-tions. These observations tend to implicate microbial release of sulfur from soils and wetlands as being an important source of atmospheric sulfur compounds in the Great Lakes Basin. Detailed data analysis suggests that the sulfur from bacterio-genic sources amounts to 10-30 $^{o}/oo$ of the total sulfur emitted annually in the basin. The study thus lends support to models of the global sulfur cycle which invoke (such) bacteriogenic emissions to explain the origin of the approximately 100 million tons of volatile sulfur compounds which cycle annually through the atmosphere.

RECENT EVENTS AND TRENDS (GEO)

This area of CCIW research is national in scope, it addresses the extent and rates of environmental change and considers their significance, particularly in terms of resource utilization, during the last 10-15,000 years. Special emphasis is placed upon the separation of cultural influences from back-ground conditions during the past 100-300 years.

The major focus of attention is directed towards: the identification of trends in the trophic status of lakes which may be related to: a) natural "aging", b) climatic change, and c) cultural impact; relating the impact of human developments within basins to specific time frames or events (to allow quantification of loading rates including contaminants - and to assess basin response); showing the significance of extreme events, e.g. floods, forest fire, cold/wet/hot/dry climatic maxima, etc., which will allow for more refined predictive

models in support of land use alternatives planning, engineering projects, and water regulation, etc.; and providing a contribution to the evaluation of long term climatic change under the lead of the Atmospheric Environment Service, in support of predictive planning for agriculture, transport and communication, and shelter and population placement.

Autecology of Shelled Invertebrates

With the completion of the 1975 and 1976 field seasons, the collection of data for the studies on the autecology of shelled invertebrates is basically completed. Taxonomic lists of the ostracode species collected and identified from 6720 stations have been prepared as CCIW unpublished manuscripts. It is expected that similar reports will be prepared for the molluscan taxa identified.

In addition to the autecological studies for shelled invertebrates already carried out, an additional 100 samples from different stations were collected to expand the autecological details of land snails. Stations were located in the deciduous and mixed evergreen forests along Lake Erie, Lake Huron and Lake Superior, extending north through the boreal forest of the Canadian shield to the woodlands, wetlands, tidal flats, and fringing tundra of Hudson Bay Lowlands.

Latitudinal Diversity of Unionid Clams

The ranges of 230 Unionacean clams from lakes and streams of Canada and the United States (primarily from the literature) have been studied and their diversity gradients calculated. The latitudinal distribution patterns owe their characters to:

1) south-north temperature gradients,
2) hydrology and paleohydrology of the continental land mass, and
3) dispersal barriers.

The less obvious features are explained by major shifts in atmospheric circulation patterns during the Pleistocene and also by the limnological properties of water bodies.

Statistical Studies

Univariate and multivariate analyses of the limnological data, collected for autecological purposes, have been undertaken for the purpose of classifying lakes and ponds. The classification is being carried out by Applied Research Division and is expected to be developed into a quantitative classification during 1977/78.

Paleoenvironmental Interpretive Models

In the fall of 1976, statistical assessment of various paleoenvironmental interpretive models was started. To date, it has been shown (Delorme et al., 1977) that the models are more complex than originally conceived.

Paleolimnology

In a study of Holocene and more recent phases of Lake Erie development (in cooperation with Hydraulics Research Division), assemblages and frequency of occurrence of mollusc shells were used as qualitative indices to outline the stratigraphy of a shoal core south of Point Pelee. The study also explains the history of the Hypsithermal for this region of the Great Lakes.

Sedimentation Rates in Lake Superior

Present-day sedimentation rates were determined at ten offshore locations, representative of the depositional basins in Lake Superior. Sedimentation rates were calculated by averaging the weight of sediment deposited above the Ambrosia pollen horizon, dated at 1890. The rates are variable ranging from a low of 25 g m^{-2} yr^{-1} (0.1 mm yr^{-1}) to a maximum va of 780 g m^{-2} yr^{-1} (2.0 mm yr^{-1}). Sedimentation rates related to the proximity of terrestrial source, circulat patterns and bottom topography. The highest rates are found locations closest to the shoreline and at the base of steep-si troughs. The present-day sedimentation rates are smaller t and are proportional to the average postglacial sedimenta rates.

A total of six million tons of fine-grained sedim is annually deposited in the lake. Erosion of the red clay bl of Wisconsin is the major sediment source accounting for u 58% of the external input. Rivers contribute 30% of external sediment load. It is calculated that the Duluth bas the repository of 37% of the total natural sediment loadin the lake.

Anthropogenic Particles in Lake Erie Sediments

Several types of anthropogenic sand-sized parti have been identified in Lake Erie sediments. They occur r abundantly along shipping lanes and in the southern part of lake offshore from major industrial ports. Their composi and distribution suggest that the four most common types derived from the activities of coal-burning and coal-carr ships. There is probably little impact on the chemistry of

lake system from these sand-sized particles. However, study indicates that a major increase in the numbers and va of anthropogenic particles occurred early in the 20th cen and they therefore provide a useful time horizon for the s of modern sedimentary processes.

METHODS RESEARCH & INSTRUMENTATION

Photooxidation and Photoelectrooxidation of M Oxide-Water Interfaces

Analytical methods for product identification been developed for some simple systems involving photoxid and photoelectrooxidation of metal oxide-water interface rotating photoelectrode has been constructed which, it is h will provide a completely new technique for detecting p chemically generated free radicals at sediment-water i faces. Photooxidation of various compounds and mat appears to offer an interesting and potentially highly eff technique for some the degradation of some pollutan shallow water systems.

Determination of Partition Coefficients of Volatile Organic Compounds

The obective of this study was to determin distribution of physiologically-active compounds and en mentally-undesirable compounds between model lipid water. These distributions are directly related to the ac lation of toxic substances in both living organisms and in parts of the environment in which such organisms must liv

Partition coefficients of toxic organic liquids benzene) between glycerol trioleate (human fat) and wate determined. For benzene, the partition coefficient is ab times larger than the corresponding coefficient for the system of octanol and water.

APPLIED RESEARCH DIVISION

TRODUCTION

The Applied Research Division of CCIW Branch is jaged in field and laboratory studies of the natural science of inland waters of Canada with a particular emphasis on the imination of lake systems through observation and modelling hniques, and on the development of analytical methodology the fields of analytical chemistry, radiochemistry, GC/MS, ctron microscopy, microbiology and remote sensing.

The work of the group has direct application in such eral-provincial studies as the major IJC references on lution in the Upper Great Lakes, and pollution from land inage; and in support of the Directorate and Service through cific method development and methodology problem investiion. A major element of the former program activity is the a management (storage, archive, and retrieval) role which is contained in the Division. With this data management ivity is combined the professional service group serving all ups on the site, providing leadership and coordination in a hnological area vital to aquatic environmental research.

The activities cover the following range:

The investigation of the occurrence and distribution of pollution problems in lake systems through cooperative studies with other Divisions of the Branch and of the federal and provincial government agencies. These utilize both field and modelling techniques.

The development of field observational techniques and models which serve the above activity.

The development of methodology for laboratory analyses of several types.

The provision of advice and information to all sectors based on the expertise and the subjects of investigation in the Division, and

The provision of analytical services to Directorate, Service, Department, and other government agencies for those variables for which we have unique capabilities in expertise or equipment.

The work of the Division is carried out in five ions:

Basin Investigation & Modelling Section
Remote Sensing Section
Analytical Methods Research Section
Microbiology Section
Data Management Section

The Basin Investigation & Modelling Section has largely involved in the final stages of several Great Lakes cts including the IJC Reference on Pollution in the Upper t Lakes, the IJC Reference on Pollution from Land Use vities, the International Field Year for the Great Lakes Ontario) and studies of the physical impact of waste heat. ese surveys data have been interpreted in terms of lake ic state, circulation and distribution of contaminants, rial balance and loadings. The Remote Sensing, Microbioal and Data Management Sections have also participated in activity. Participation of BIMS in studies of similar cts has also taken place in Kootenay Lake, B. C. BIMS nues its involvement in the Great Lakes surveillance am and in the development and testing of lake system ls.

The Remote Sensing Section engages in the study novement of light conditions inside lakes, and reflected lake and land surfaces, for the purposes of interpreting s both a research program and a tool used to assist other ists and engineers in their interpretation of survey results, the the areal variations are particularly revealing or conditions (e.g. turbidity and chlorophyll in lakes or recharge areas in river basins) from optical measurements and from aircraft and satellite data in the optical radiation bands. where continuous profiling possible with optical measurements is indicative of conditions that, at present, can only be observed serially.

The Analytical Methods Research Section carries out research in a wide range of new or improved analytical methodologies for identification and quantitative measurement of chemical constituents. They provide special research and analytical service in electron microscopy, GC/MS and radiochemistry. They also carry out research in radio-ecology and surveillance related to radionuclides.

Further to the involvement of the Microbiological Laboratory Section in IJC studies, noted above, this Section also engages in study of analytical methodology for both health related indices and lake microbiology. They have carried out contract studies under the Canada-Ontario Agreement and for the Environmental Protection Service. This Section is also responsible for provision of the service of a microbiological laboratory facility to all groups at the Centre and to federal agencies in the Region.

Closely allied with field investigation is the need for efficient and reliable data archiving and data manipulation. The Data Management Section serves both functions at the Centre with the aim of enhancing data entry and accessibility for improved research productivity. The link between data, interpretation and modelling is strong and the data management function, therefore, essential to the total success of our endeavours.

COMMISSIONED STUDIES

Thermal Structure and Circulation of Kootenay Lake

Knowledge of the thermal and current structure of fjord lakes and its response to reguation of the mass, energy and quality of the inflow and outflow of the lake is important to the problem of assessing the impact of regulation of the lake-river system for the generation of hydroelectric power, flood control, agricultural uses, and for international agreements. A three year programme of investigation was established in Kootenay Lake in the spring of 1976.

The analysis of the experimental data collected in 1976 is in the early stages of completion. Some processes affecting the thermal structure and thus the depths of the chemically and biologically important zones have been identified. In Figures 1 and 2 daily averaged temperature profiles in the southern end, Twin Bay, and in the northern end, at Schroeder Creek, demonstrate that the thermal structure changes dramatically over periods of about eight days. Careful inspection of the diagrams reveals that the oscillations of the thermal structure are out of phase at the two ends of the lake. Another process which rapidly alters the thermal structure at a single point are warming events which evidently progress from a source region in the southern half to the northern portion of the lake over a period of several days. A sudden warming event is shown in Figure 3. Further study is planned to gain an understanding of these and other processes controlling the formation and erosion of the thermal structure in fjord lakes in order that the response of the thermal structure to regulation be better understood.

Reservoirs and Impoundments

It has long been recognized that the construction of reservoirs has certain environmental and ecological effects other than those intended. For example, dams are often obstacles to the movement of anadromous fish, and much effort has been devoted to the design of fish ladders and other means of maintaining fish populations in dammed streams.

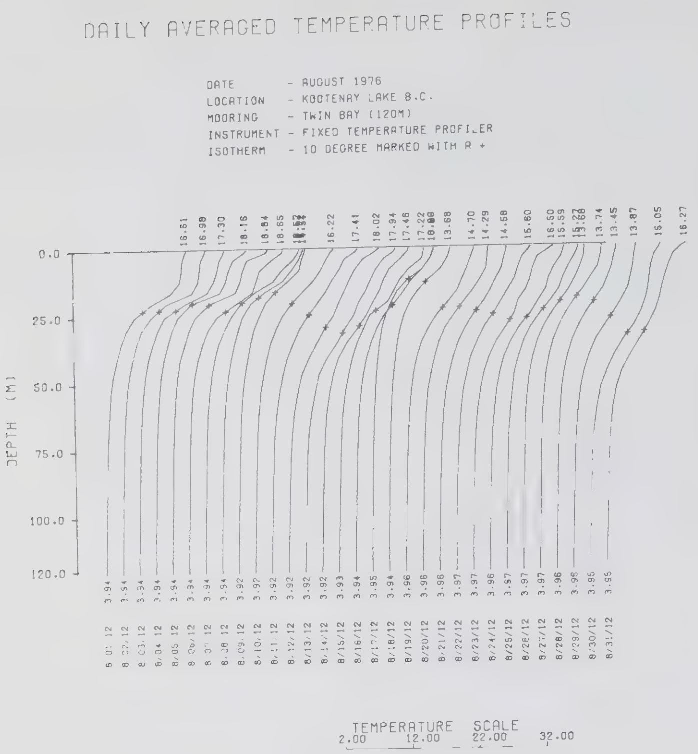


Figure 1 Daily averaged temperature profiles for the month of August, 1976 at the southern end of Kootenay Lake (Twin Bay).

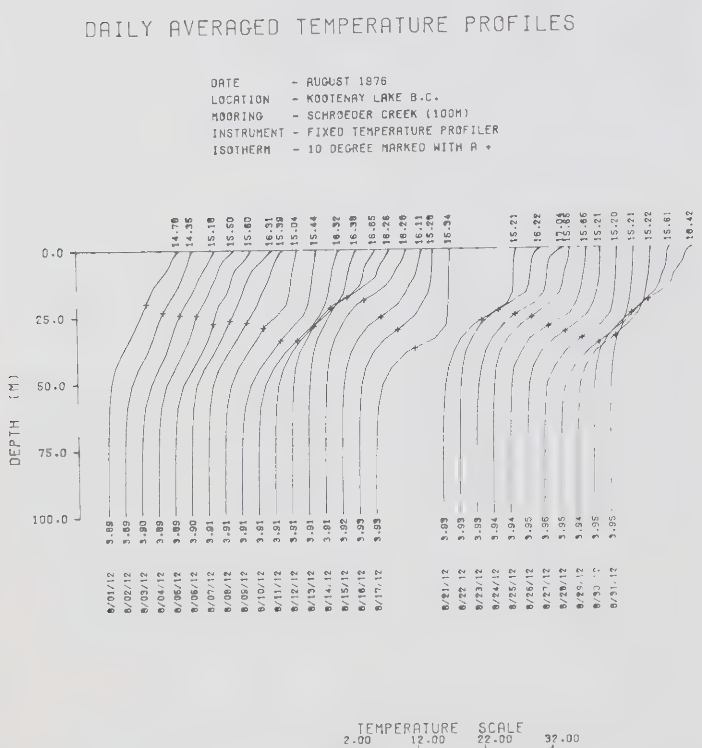


Figure 2 Daily averaged temperature profiles for the month of August, 1976 at the northern end of Kootenay Lake (Schoeder Creek). Temperatures are in celsius.

However, during recent years it has become ap rent that reservoir construction may have other effects wh are less immediately obvious and may be distant in space fr the actual construction, but which may be at least as signific as the more direct and obvious ones. For example, the cha in the flow regime may have very far-reaching consequen downstream. An almost classic example of this is the effec the W.A.C. Bennett Dam on the Peace-Athabasca Delta. V extensive changes began to occur in the delta shortly after dam was closed and, since these were disadvantageous for local population, it was necessary to undertake a very lo research programme to determine what measures could bes used to restore the original conditions.

Estuaries, and even adjacent parts of the sea, also be affected. There is some evidence that regulation of Saint Lawrence River may already have affected fish catche the Gulf. Possible effects of this kind have been a m concern for those responsible for determining the ecolog consequences of the James Bay project.

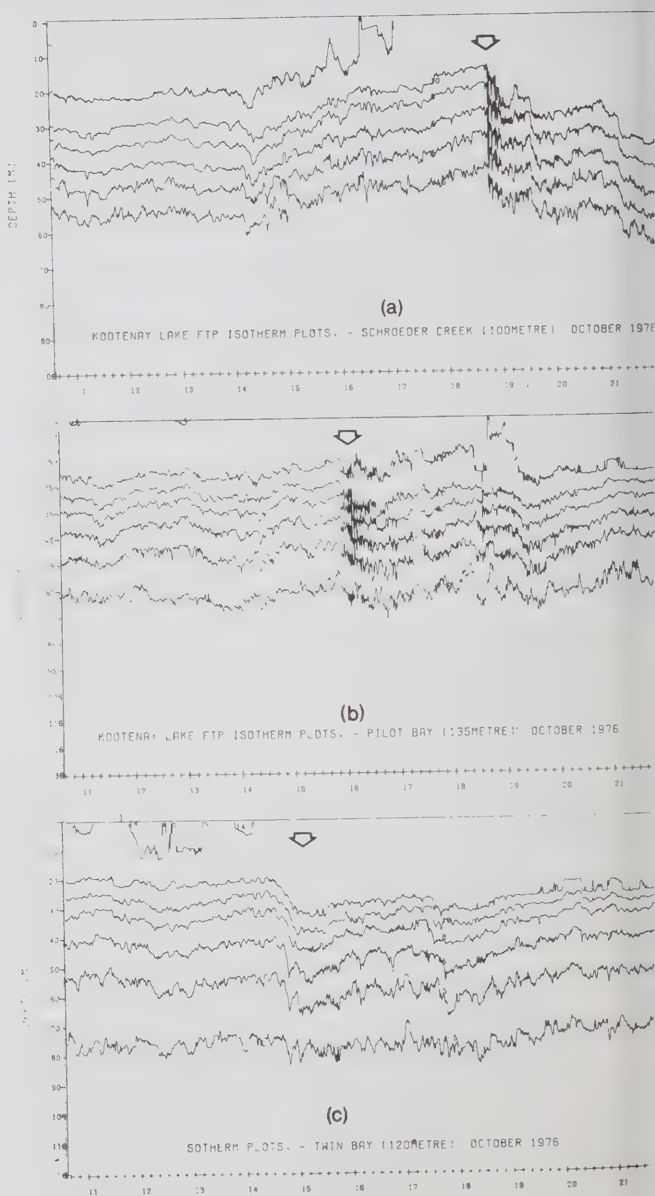


Figure 3 Isotherm displacements in deg C in time and for (a) northern end, (b) central lake, (c) sou end of Kootenay Lake, October, 1976.

It is also well established now that large and deep ıpoundments may lead to seismic distrubances in their cinity. There has already been at least one instance of this in ınada.

In order to provide a rational basis for the assess-ent of these and other environmental risks, it has been oposed to prepare a handbook on environmental effects of ıpoundments under Canadian conditions to serve as a guide to ose responsible for such undertakings. As a preliminary to is, a review has been prepared on the present state of owledge of these matters in Canada and will be ready for culation very shortly.

Chemistry of Natural Waters

The escape of ammonia from water to the atmo-here has been measured both in the field and in the laboratory following the decrease with time of ammonia concentration water. The laboratory measurements were done in a small nd tunnel at pH values of 8.3, 9.1 and 10.0 and at wind speeds om 1 to 6.5 ms^{-1}. The ammonia concentrations ranged up to 00 $\mu g\ \ell^{-1}$. The exchange coefficient, Km, varied linearly om about 1.5 cm hr^{-1} at 1 m s^{-1} to about 3.5 cm hr^{-1} at 6.5 m . This relationship was based on data obtained at all three values. The field measurements showed considerable atter, but were consistent with the laboratory results. On the sis of these results, the escape of ammonia from water can be nsiderable (the maximum observed rate was around $\mu g\ \ell^{-1} hr$), but depends on the pH, since the percent of un-ized ammonia, which is the species that escapes, becomes ose to zero at pH 8.

KE SYSTEMS

Coastal Physical Processes

Coastal areas are increasingly used for recreation and resource development, particularly siting of thermo-nuclear power plants, and waste discharge systems. An understanding of the characteristics of coastal current and thermal regimes is essential to determine their driving mechanisms and to investigate their effect on biological, chemical, and geological processes which occur in the coastal zone and to estimate the transport and dispersion of pollutants such as thermal and other waste effluents that are likely to be discharged into coastal waters. The Canada Centre for Inland Waters has conducted several studies specifically designed to characterize, in a climatological sense, the coastal zone water movements that are of particular relevance to dispersive characteristics in the Great Lakes.

The flow characteristics in the coastal zone are extremely complex due to the interactions of a number of hydrodynamic and meteorological variables including wind stress, bottom friction, and density gradients, etc. and , therefore, deterministic predictions at present are not feasible. For the immediate future, however, a statistical or climatological approach appears to be realistic for solutions of many coastal water resource management problems. With this objective in mind, CCIW is currently in the process of publishing statistical and climatological reports based on detailed field observations at specific but typical coastal sites. One such report was published by CCIW and Ontario Hydro in 1976 based on a cooperative study during 1974 near Douglas Point, Lake Huron, where a major nuclear power complex is currently under construction (CCIW Report No. 17). Some typical results from this report are reproduced in Figure 4 and 5. Shown here are monthly summaries of wind and currents for August, 1974 for two current meter moorings located at 1 km and 6 km from shore. An important observation one can make from these plots is that strong longshore currents within a few kilometres from the shore dominate organized flow patterns in the Great Lakes.

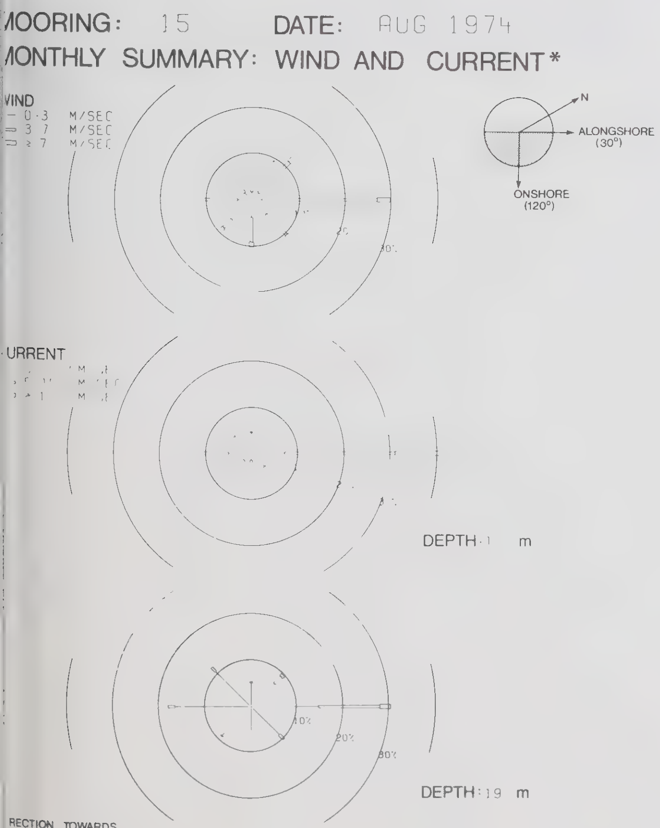


Figure 4 Summary of Wind and Currents, August 1974 for a Current Meter Mooring at 1 km from Shore

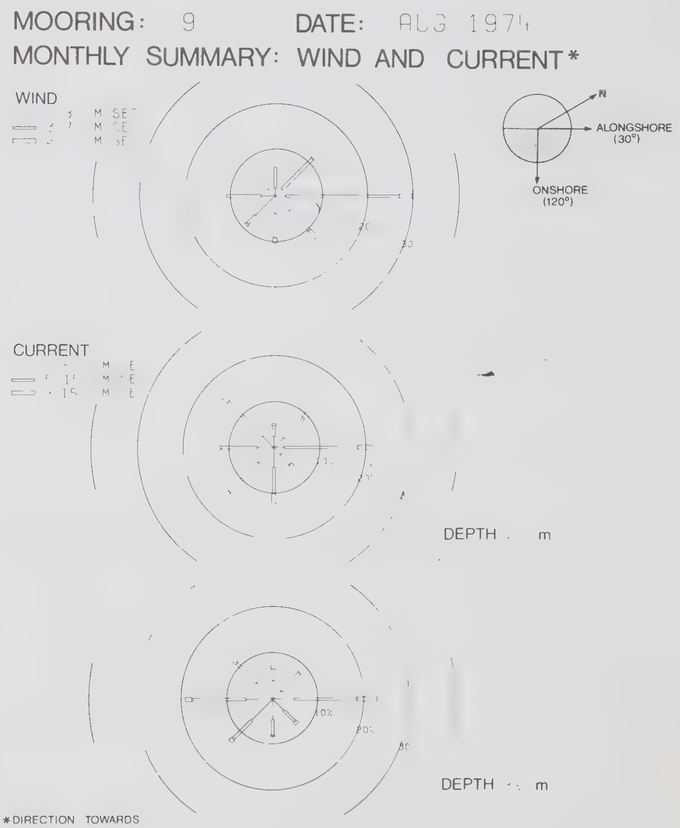


Figure 5 Summary of Wind and Currents, August 1974 for a Current Meter Mooring at 6 km from Shore

An important scientific objective of these studies is to resolve the large scale transport and exchange processes in the coastal boundary layer. Towards this objective, detailed calculations have been performed to determine the mean flow properties, horizontal turbulence, current stress, and dispersion characteristics of coastal currents for specific areas of the Great Lakes. Figure 6 shows a typical result from these calculations. Shown here are kinetic energy spectra of coastal currents from four current meters located at distances ranging from 1 km to 6 km from the shore for a typical summer period. It is of interest to note that while the inertial currents dominate offshore, these currents are drastically modified nearshore. As a consequence, there is a transition zone where rotary inertial currents are gradually modified and are forced to flow more or less parallel to the local shoreline.

(b) Inter-basin Exchange Studies, Lake Huron

The program of study of the interchange of water and materials between lake basins continued during the year with both field work and analysis and interpretation of existing data.

The field program was designed to provide the information required for estimation of the exchange between North Channel and the main body of Lake Huron. Knowledge of this exchange and its impact on materials balance for North Channel was lacking when the Upper Lakes Reference Report was written. During the period May-November, time series measurements of water currents and temperatures were made at up to four depths in Mississagi Strait and Detour Passage and at several locations in North Channel. Meteorological variables were also measured from buoys anchored in the middle of North Channel. Surveys at monthly intervals were made to elucidate the thermal structure and heat content of North Channel.

Analysis and interpretation of current and temperature measurements made during 1974 in Main Channel, which connects Lake Huron and Georgian Bay, were completed during the year. The principal finding was that thermal stratification in summer permits up to ten times more transport between basins than would occur if no stratification existed. Figure 7 shows some of the results of this study. On the left in that figure are mean flow values observed at three depths in a mooring in Main Channel, while on the right is the vertical profile of current speed derived from an analytical solution for a two-layer model in which the lower layer is stratified. The model solution demonstrates what can only be inferred from observations, namely, that there can and must be a significant transport of surface water from Lake Huron to Georgian Bay.

Impact of Energy Development

(a) <u>Thermal Plume Surveys: Winter Period Sinking Plume</u>

In support of the IJC heat studies, a field measurement program was undertaken during the winter of 1975-76 to define the characteristics of a winter period sinking plume phenomena.

During January, February and March, 1976, field measurements were recorded in the immediate vicinity of the thermal outfall from the Pickering Generating Station of Ontario Hydro located on the north shore of Lake Ontario. This study was designed to collect thermal, meteorological and current data in the area with the intent of defining the strength, extent and configuration of sinking plumes under different environmental conditions. Physical data of this type are also necessary for plume model verification during winter conditions.

Sinking plumes can occur during the late winter months when ambient conditions and sufficient density gradients allow a normally buoyant plume to sink at some distance from the point of discharge. This occurrence results in sudden bottom temperature changes of several degrees and corresponding thermal shocks to the resident biota.

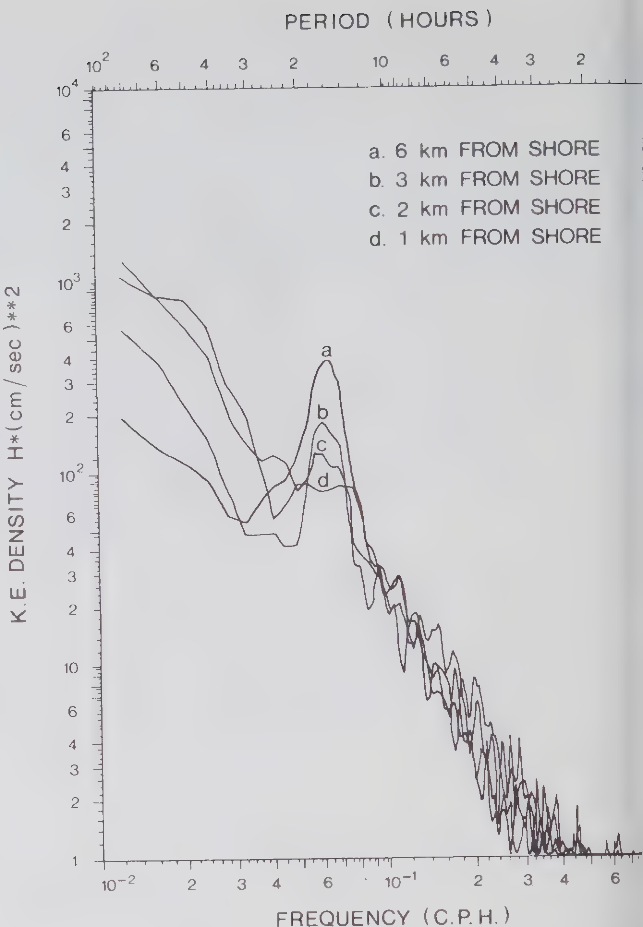


Figure 6 Kinetic Energy Spectra of Coastal Currents for a Typical Summer Period

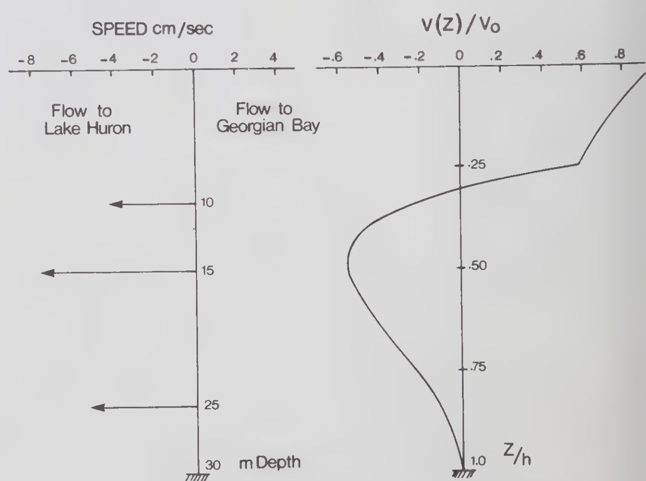


Figure 7 Mean currents observed at Mooring 7, Main Channel, during May-November 1974 (left), and vertical profile of current speed for steady, wind-driven channel flow wher homogeneous surface layer of depth Z = 0.25 h overlies stratified lower layer (right).

Figure 8 shows a view of the station that pictor defines the areal extent and configuration of the sinking p effect during a bathythermograph survey taken over a peri

ur hours on February 5, 1976. In this figure, the 3 and 4 egree isotherms are used to define the plume and are plotted rface to bottom in an isometric manner in an attempt to show e respective isotherms as a 'front'. Solid continuous lines are e surface occurrence while the broken lines are the bottom ccurrence of the front. Lines joining the two are either solid or oken, the latter implying a hidden line condition; that is the rface of the front is further offshore than the bottom.

Comparison of presentations of similar surveys show early the variability of the plume in areal extent and strength. e time-series measurements allow a statistical interpretation the plume behaviour with time and correlations with eteorological conditions. Information on plume behaviour of is type is used ultimately to determine the chemical and ological implications of discharging large quantitites of ated effluent as a surface discharge.

) Nearshore Plume Simulation Models

Several computer models have been developed in-use and by contracted work for predicting nearshore thermal umes, waste effluent, and patches. Efforts have been made to k these models to existing biochemical models. These are rt of an integrated study to develop a general program ckage with greater flexibility and versatility in the prediction the movements and reactions of waste effluents and, in rticular thermal discharges, in the coastal environments. gure 9 shows the predicted and observed centreline tempera-res in a thermal jet for the nearfield (0-½ km). Attempts are ing made to interface the nearfield thermal jet model with a rfield (½-2 km) advection-diffusion model, which can in turn linked to the lakewide (2 km and over) water quality and ansport model. The interfacing of the model is designed to ve a better understanding and assessment of the environmen-l impact of waste effluents and to provide some guidelines to e definition of mixing zones for various contaminants. The rge volume of coastal zone current data collected at CCIW ovides an excellent basis for developing and verifying models. rious numerical methods and grid designs have been deve-ped to accommodate such physical, semiempirical relation-ips as variable eddy diffusivities.

Atmospheric Loading

Materials transported by the atmosphere and deposi-d on both aquatic systems and terrestrial drainage basins have en shown to consistute a significant portion of the total dings of such systems. The atmospheric loadings of ological nutrients, major ions and toxic substances were estigated in the Great Lakes Basin during 1976 through ograms of precipitation chemistry and atmospheric transport d deposition modelling.

Precipitation chemistry measurements were conduc-d by the IWD Water Quality Branch adding to the extensive ta base existing for the Great Lakes Basin. This data base w contains over five years of records for several stations and nstitutes a substantial evidence of the characcter of precipit-on chemistry for the basin. Limitations of the bulk samplers ed in the network have been demonstrated and actions were ken during 1976 to institute automatic wet-dry sampling on an erlap basis to provide continuity with past observations. ecial samples were collected at several stations for synthetic ganic analysis. The results of the latter are described ewhere under toxic substances studies.

Through contract with H. G. Acres Consulting vices Ltd., Atmospheric Loading estimates were obtained for Lower Great Lakes and the Great Lakes drainage basins. th atmospheric transport models and precipitation chemistry a were employed to achieve these estimates. Figure 10 from final report of the Acres contract illustrates the estimated gnitude of atmospheric loading of several important water ility parameters to the drainage basins of the Great Lakes. se estimates will be incorporated into the anlysis of the IJC, lution from Land Use Reference Group, to assess the

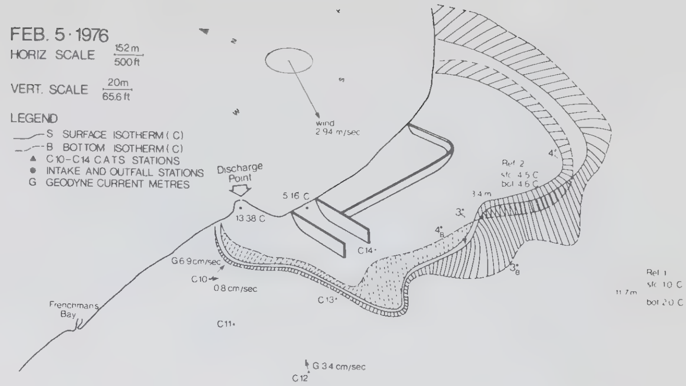


Figure 8 Areal Extent and Configuration of the Sinking Plume

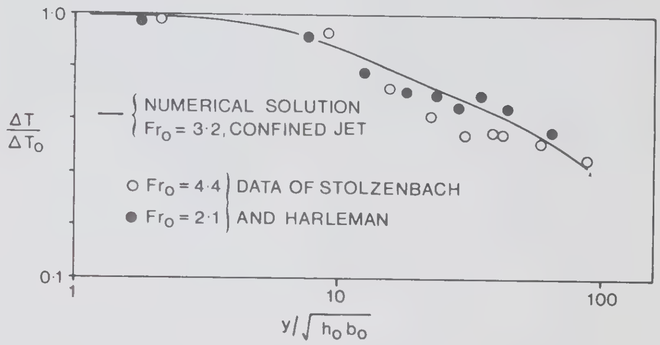
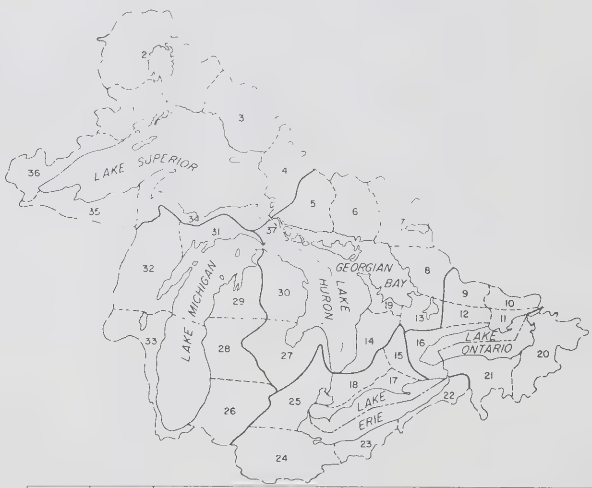


Figure 9 Predicted and Observed Centreline Temperatures in a Thermal Jet for the Nearfield (0-½ km)



LOADING ZONE	10^3 km² AREA	10^6 kg/YEAR SO₄	10^6 kg/YEAR TOTAL N	10^6 kg/YEAR PARTICULATES	10^3 kg/YEAR TOTAL P	10^3 kg/YEAR Cd	10^3 kg/YEAR Pb	10^3 kg/YEAR Fe
1	13.6	23	2	5	35	5	100	510
2	43.3	62	4	12	90	11	250	1200
3	20.5	49	3	8	53	7	150	830
4	15.1	57	4	9	57	7	170	930
5	14.3	69	5	11	62	8	200	1100
6	15.4	140	5	11	61	8	190	1100
7	18.2	130	6	14	75	10	240	1700
8	13.1	68	5	11	55	8	190	1700
9	7.1	27	3	5	26	4	88	660
10	5.3	25	3	5	26	4	99	990
11	3.2	21	2	4	19	3	74	740
12	5.3	29	3	5	25	4	9	900
13	7.9	45	4	7	35	5	120	1100
14	11.0	76	8	13	63	9	230	2000
15	6.8	50	5	8	39	5	130	1100
16	8.8	65	7	10	51	7	180	1600
17	6.3	60	7	9	44	6	150	1500
18	10.5	93	10	13	62	9	220	1800
19	4.1	26	2	4	19	3	66	470
20	17.4	90	10	17	100	16	370	3700
21	14.8	110	12	19	96	14	360	3600
22	5.0	51	5	8	39	5	140	1300
23	8.1	97	10	15	70	9	230	2300
24	23.6	180	21	32	160	21	530	4800
25	15.0	130	16	20	95	14	360	2200
26	23.2	160	20	28	150	21	510	2900
27	20.4	160	19	23	110	18	440	2400
28	21.3	130	16	23	120	17	430	2300
29	12.7	53	7	9	55	8	180	950
30	16.9	74	8	13	71	10	240	1300
31	9.0	31	4	7	41	6	130	680
32	32.1	100	13	20	140	18	390	2000
33	16.2	110	14	17	110	15	360	1700
34	12.7	35	4	8	48	6	150	780
35	13.6	27	3	6	38	5	110	550
36	17.6	29	3	6	51	6	130	620
37	2.7	11	1	2	13	2	44	230

Figure 10 Drainage Basin Loadings in 1974. Atmospheric Loading of the Lower Great Lakes.

relative importance of this source of materials to the total basin loadings.

COMMISSIONED STUDIES

Upper Lake Surveys

Surveys of Lakes Huron and Superior conducted during 1973 and 1974 provided the data base for analysis of the lakes' physical and chemical characteristics which were reported to the International Joint Commission and will be included as portions of the Upper Lakes Reference reports.

The analysis incuded specific studies of importance to understanding the mass balance of materials in the lake waters and of the lake optical properties.

Water and materials budget studies were initiated to assess the impact on materials balance of Lake Huron of the exchange of water with Georgian Bay. Based on 1974 meteorological and hydrological data, it was determined that during the stratified season the transport of water between Georgian Bay and Lake Huron is startified also (Figure 11) with surface water (0-5 m) moving into Georgian Bay while continuity is maintained by net outflow at depths greater than 5 m. Residence and flushing times for Georgian Bay were estimated at 7.2 and 8.5 years respectively.

Because of their effects on water quality, total phosphorus, nitrate + nitrite, total dissolved solids, chloride, and dissolved reactive silicates were selected by the IJC Water Quality Board for materials-exchange analysis between Georgian Bay and Lake Huron. Net loading of sources to Georgian Bay is illustrated in Figure 12. By budget analysis, it was found that phosphorus retention in the bay is 53.2 percent, a phenomenon consistent with observations in other lakes. Other nutrients (SiO_2 and NO_3) are retained as well though their retention is never more than 35 percent. Budgets for total dissolved solids and chloride agree to within five percent.

Thermal energy budget computations for Lake Superior provided the first comprehensive set of values for that lake and related directly to problems involving the thermal characteristics and biological aspects of the lake. Data for 1973 indicated a heat content change of 62 499 cal cm^{-2} compared to 64 800 cal cm^{-2} from long-term results. Energy budget results were used to estimate monthly evaporation totals which were compared to water budget and mass transfer values (Figure 13). The remarkable correspondence between the energy budget and water budget evaporation totals to within 1 cm for most months indicated the reliability of computed Lake Superior residence and flushing times determined from the water budget used in such applications as interlake materials transport analysis and management of the lake system.

Light transmission has been proposed as a water quality parameter for the Great Lakes. The problem being addressed is degradation resulting primarily from substances attributable to municipal, industrial or other discharges relating to human activity which may be detected as significant changes in water transparency. For example, mean potential photic depths for zones in Lake Superior, Lake Huron, and Georgian Bay are illustrated in Figure 14. They indicate that light is least attenuated in the midlake areas and moderate to highly reduced transparency occurs in the nearshore. Particular areas of low light penetration include Duluth Bay and Thunder Bay in Lake Superior, and Saginaw Bay and portions of North Channel in the Lake Huron system. The measurements as illustrated in Figure 14 now form a baseline against which later conditions may be compared to quantify changes which may occur.

Survey and Surveillance Methods

During 1976 the continuing activities of the IJC Water Quality Board were furthered and assisted by staff of the Basin Investigation and Modelling Section. Two major areas were investigated on behalf of the IJC Subcommittee. A study to determine the changing conditions of nutrient concentrations in Lake Ontario indicated that over an eight year period (1968-

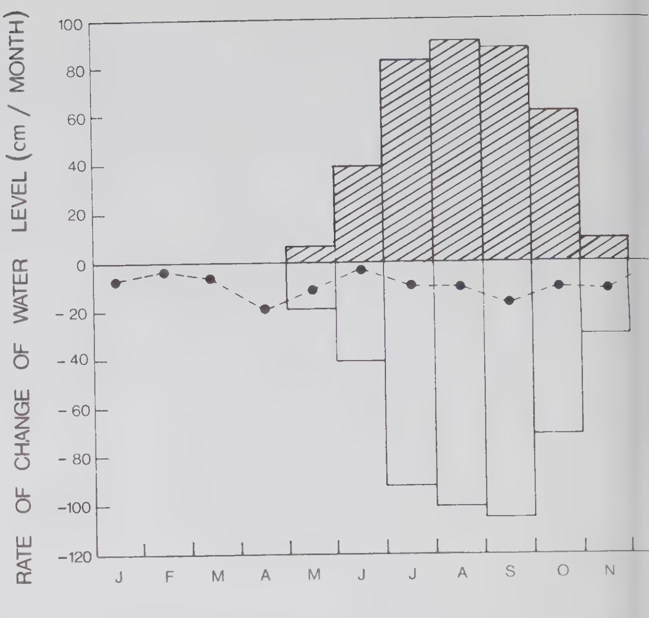


Figure 11 Potential rate of change of Georgian Bay lak level due to exchange with Lake Huron durin 1974 (cm/month)

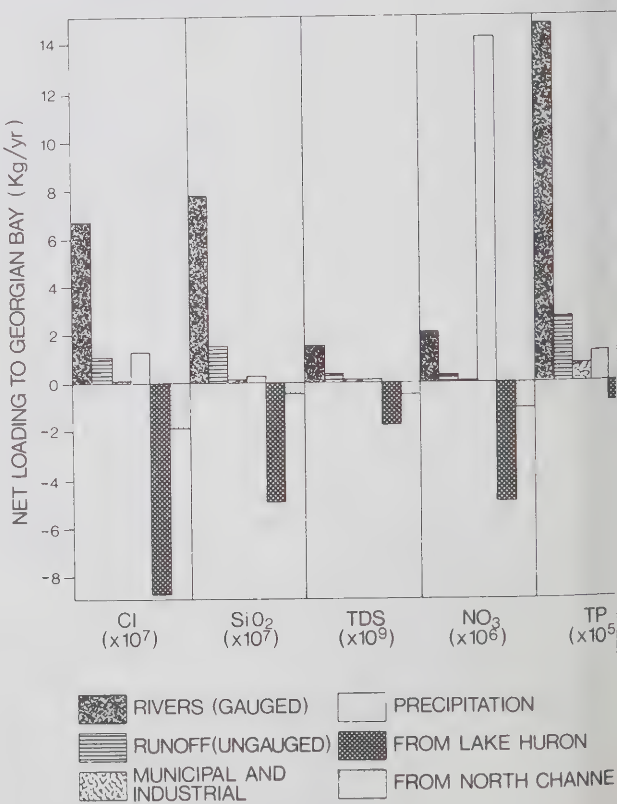


Figure 12 Net loading contributions of sources to Geo Bay 1974

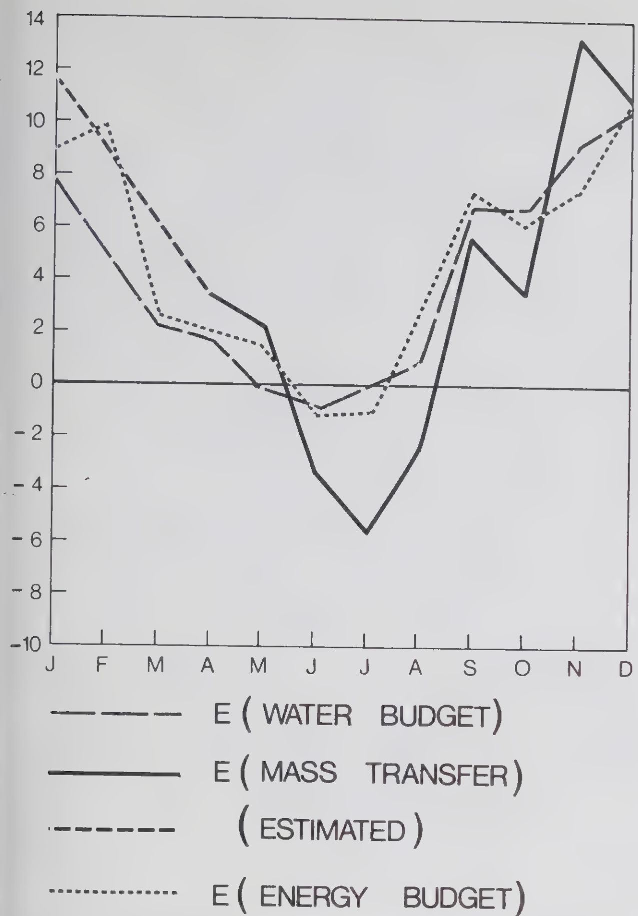


Figure 13 Comparison of monthly evaporation estimates for Lake Superior 1973

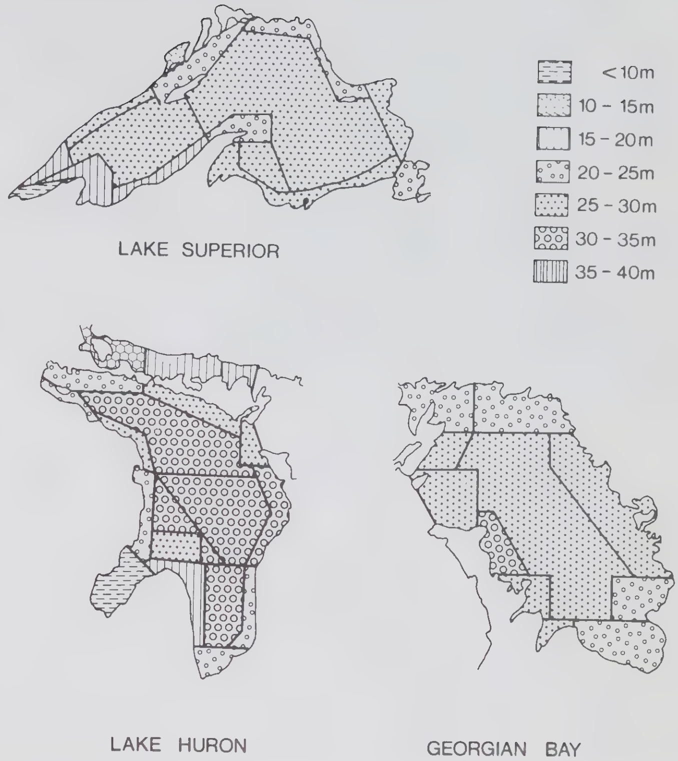
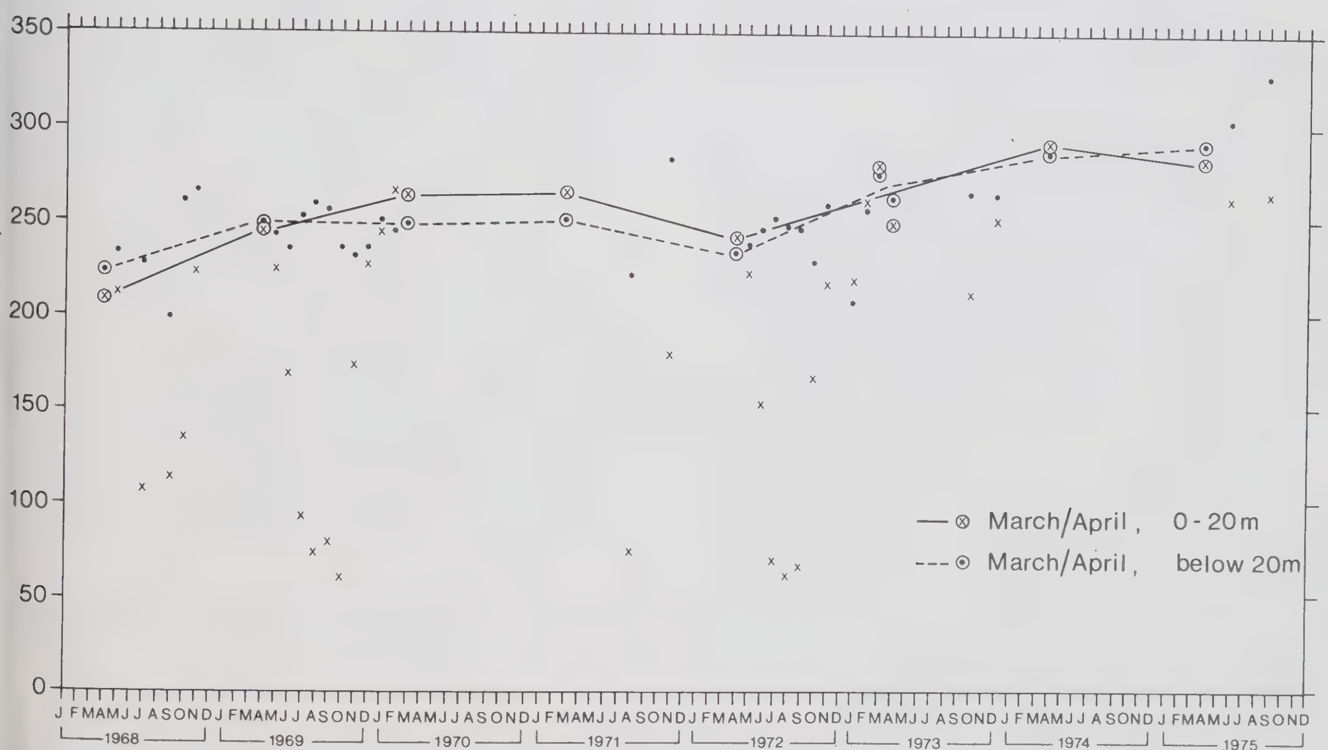


Figure 14 Mean potential photic depth for zones of Lake Superior, Lake Huron and Georgian Bay for the wavelength 400-500 nm.



WHOLE LAKE VOLUME WEIGHTED MEAN - AVAILABLE NITROGEN as (NO_3+NO_2) as N + (NH_3) as N

Figure 15 Lake Ontario - Available Nitrogen, 1968 - 1975

1975) there was no significant trend, either increasing or decreasing, in the whole lake phosphorus concentrations considering total phosphorus and soluble reactive phosphorus in the spring isothermal periods. The study did, however, indicate a significant increasing trend in nitrogen that is available for biological growth. The rate of increase of early spring values was determined to be 9.6 $\mu gN\ \ell^{-1} a^{-1}$ (see Figure 15). This represents an increase of 20% over the 1968 nitrogen content over an eight year period.

In addition to these specific studies, staff of the Applied Research Division provided continual assistance and advice to the IJC committees and government agencies in the development and formulation of the Great Lakes Surveillance Program. This program has been designed to provide the water quality information that will be required over the coming years for the evaluation of the success of remedial programs that are implemented to preserve and protect the natural aquatic resources of the Great Lakes Basin.

Development of Predictive and Operational Models

(a) Mathematical Modelling:

A considerable part of the interdisciplinary research effort at CCIW is concerned with development of mathematical models of lake ecosystems. The ultimate objective of such models is to aid resource managers in predicting environmental consequences of various social and industrial developments. The more immediate goals of these studies are to gain insight into the functional relationships within the ecosystems of large lakes, to identify the areas of most serious deficiency in our knowledge, and to set research priorities.

In view of the large dimensions of many Canadian lakes, in particular the Great Lakes, the modelling effort has concentrated heavily on the spatial variations of water quality parameters. These are intimately associated not only with the regional distribution of loadings, but also with physical processes in a lake. Vertical stratification in summer, horizontal temperature gradients between nearshore regimes and deep water, and redistribution of dissolved and suspended matter by water tranport, have all been found to have pronounced effects on the biological behaviour of the system.

Recent ecological modelling studies have dealt specifically with two Great Lakes, namely, Lake Ontario and Lake Superior (Simons, 1976; Lam and Halfon, 1976). In each case, the simulation project was a direct follow-up to an extensive observational program carried out on the respective lake in 1972 and 1973. Verification of model results against this data base makes it possible to pinpoint the strong as well as the weaker components of current ecosystem models. Not surprisingly, the mathematical framework for the biological model component is generally found to be less satisfactory than its physical counterpart. A judicious application of physical models can thus be used to optimize data sampling for the purpose of further development of biological models.

An example of the output produced by a two compartment phosphorus model in Lake Superior is presented in Figures 16 and 17. A map of observed conditions in September, 1973 is also presented. This phosphorus model is coupled with a hydrodynamic model which simulates lake currents and other water movements. The coupling of the models allows the simulation of water quality conditions all over the lake. Different conditions are observed because of the influence of many physical and biological factors, namely, wind conditions, water temperature, sunlight, day length, light extinction in the water, lake topography, shoreline configuration, river sources, atmospheric loadings, municipal and industrial discharges, algae, and biological production of organic matter. These factors are formulated in a mathematical form and incorporated in a comprehensive water quality model which is programed for a high-speed computer.

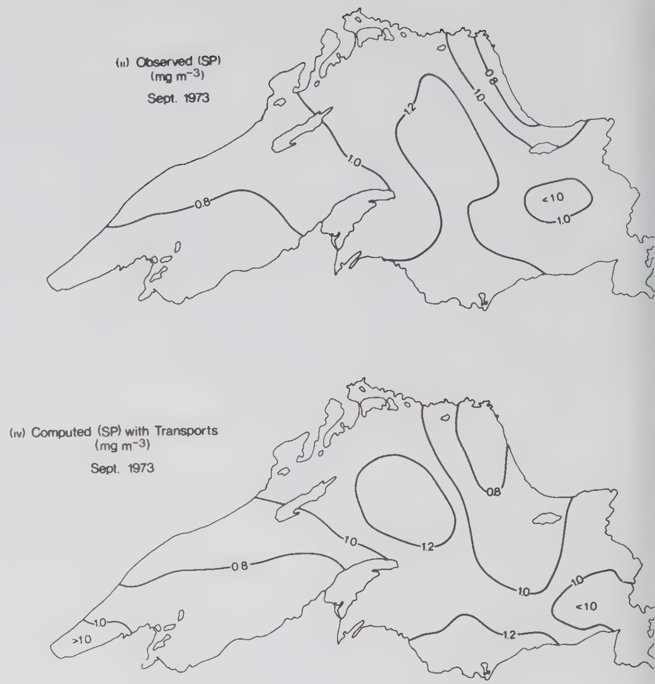


Figure 16 Map of soluble phosphorus (SP) distribution obse[r...] in September, 1973 (ii) and simulated with [...] mathematical model (iv).

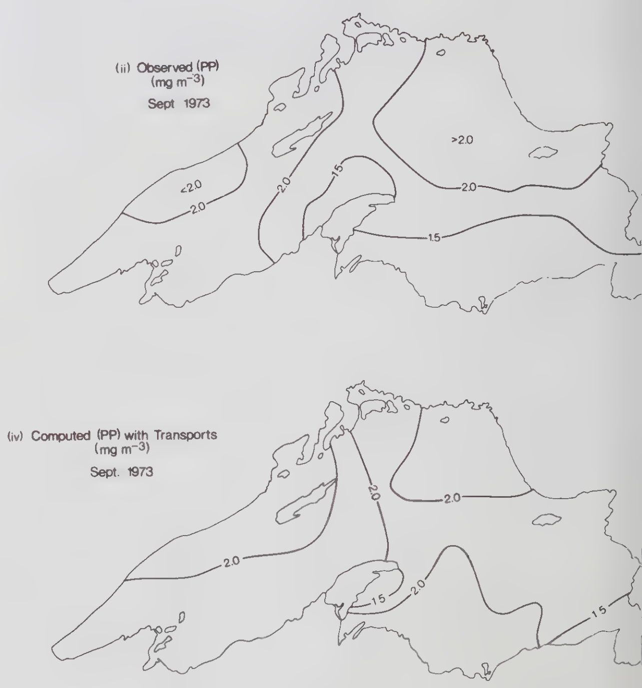


Figure 17 Map of particulate phosphorus (PP) distrib[...] observed in September, 1973 (ii) and simulated [...] the mathematical model (iv).

Additional research on model formulation is do[...] a theoretical basis (Halfon, 1976 a, b, Halfon and Reg[...] 1977) to improve various aspects of simulation models o[f] ecosystems. Particular attention is paid also to stati[...] considerations in conjunction with model verification an[...]

spatial and temporal distribution of limnological data utilized for this purpose. At the same time, continuous evaluation takes place of existing water quality models which have been proposed for management considerations by various research groups. This involves statistical comparison of simulated conditions with long-term collections of water quality data.

(b) Statistical Models of Water Quality

It is important in limnological investigations to classify a given water body into regions or zones according to the values of a specific character or a set of characters such as chlorophyll a, Secchi disc depth, bacteriological population, etc. Such classifications help in the following:

i) The determinations of the regions which are of high risk to the health of the human population.

ii) The estimation of the variability level in each region and its relative importance to the total lake variability. These estimates will give the guide for planning future sampling programs by (a) the estimation of the sample size required to achieve preassigned confidence level in the estimate of the mean values of the lake; and (b) the allocations of these samples (sample design) to the different regions, and, finally,

iii) The elimination of the spatial influence from observed data in order to concentrate on other sources of variability such as the temporal changes and the determination of the effectiveness of a remedial program on the water quality.

To give an answer to some of these problems a statistical model was developed to study the spatial and temporal variations in the values of a specific variable or a set of variables. This model gives estimates for the temporal and the spatial variability in the data and divides the lake objectively into a set of regions. A computer program was written for the application of this model and is available in the CCIW computer library for general use.

The results of applying this model to the 15 surveillance cruises conducted on Lake Ontario 1974 have been reported. Figure 18 gives the classification map obtained for chlorophyll a. In the graph the lake is divided into seven zones. Zone one, displaying the minimum chlorophyll a concentration, is found centrally located in the west end of the lake, while zone seven, the highest chlorophyll a concentration, is found off Oswego and in Henderson's Bay.

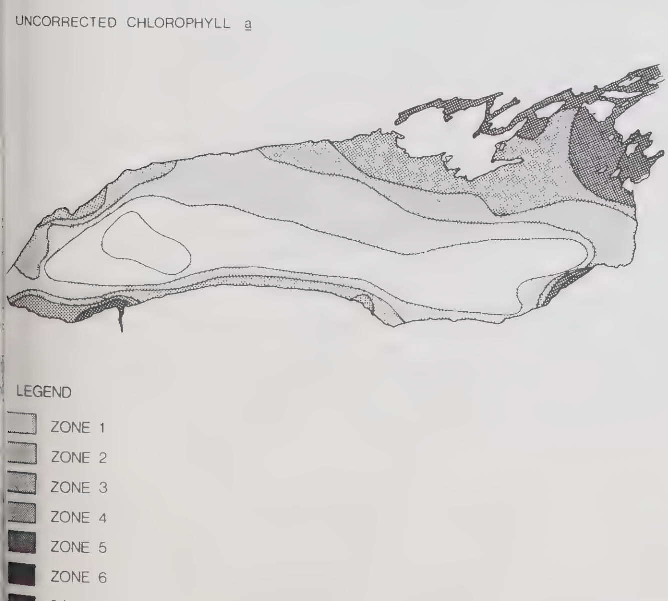


Figure 18 Chlorophyll a in Lake Ontario

REMOTE SENSING

Methods Research and Instrumentation/Commissioned Studies

Environmental Spectro-Optics

The Remote Sensing Section at CCIW is engaged in spectro-optical studies of aquatic environments using satellite, airborne, ship-acquired and ground based data. During 1976, these studies have achieved significant developments in the areas of:

a) pattern recognition studies of multispectral digital apparent radiance data acquired by the LANDSAT satellites;

b) optical modelling of the in situ interaction of light with the organic and inorganic components of the water column;

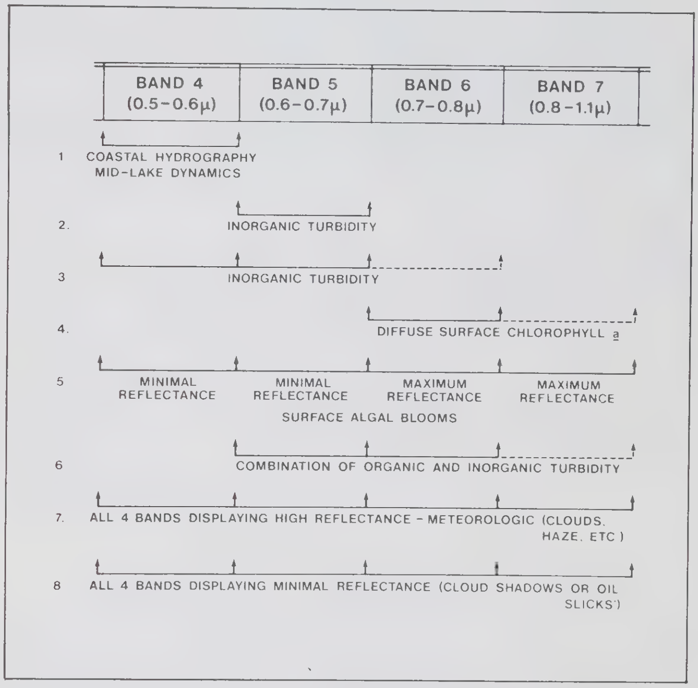


Figure 19 Physical Interpretation of Landsat-1 Digital Data Based on per-band Pattern Recognition

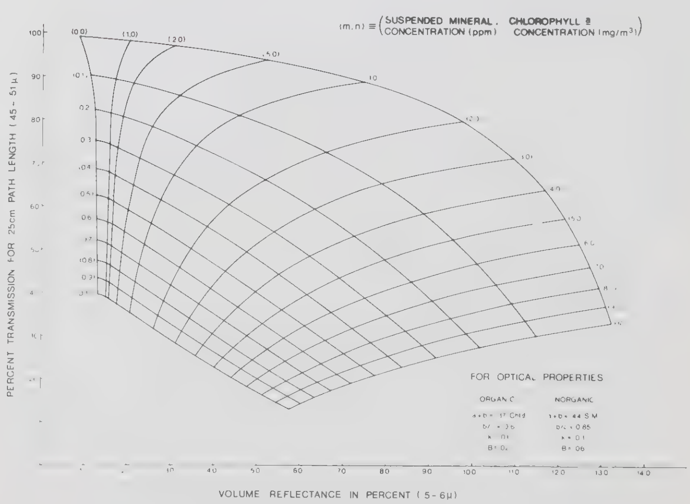


Figure 20 An Optical Model for Determining Suspended Mineral and Chlorophyll a Concentration

Figure 21 Location of Groundwater Discharge and Recharge Areas in Scotland Area as Delineated by Landsat-1 (Band 7) on March 20, 1974

c) delineation of groundwater regimes by means of multispectral satellite and airborne thermal data, and;

d) internal oscillations of Lake Superior.

Figure 19 illustrates the results of pattern recognition studies of the digital LANDSAT-1 radiance data. Patterns acquired over the Great Lakes which are readily apparent in individual or combinations of the satellite energy Bands (Two in the visible and two in the near infra-red spectral regions) are interpreted in terms of water quality (suspended inorganic materials and/or chlorophyll a concentrations), coastal hydrography, mid-lake dynamics, and meteorological phenomena.

Figure 20 illustrates the development of a three component optical model for the in situ determination of separable inorganic (suspended mineral) and organic (chlorophyll a) components of a water column by the simultaneous measurements of the optical transmission and volume reflectance at a given point in the column. The model has direct applicability to clear, oligotrophic waters such as comprise the Upper Great Lakes, but requires considerable modification before it may be applied to the Lower Great Lakes.

Figure 21 delineates the locations of groundwater discharge and recharge regimes as determined from the LANDSAT-1 digital data acquired over a southern Ontario basin in early spring when the maximum groundwater-induced thermal gradients are in effect. The classification of Figure 21 is directly comparable to the thermal profile of the basin as measured from aircraft and the energy return from the basin is directly corollatable to the water table depth. This work has also been extended to include the classification of groundwater pathways through a satellite determination of the ability of the soil to sustain vegetative canopies during the summer season.

Figure 22 a 19th nodal internal standing wave. The interpretation is consistent with ancillary thermal structure and time series current measurements of the lake.

These spectro-optical studies are more fully discussed in recent publications and manuscripts currently in preparation.

Figure 22 A 19th Nodal Internal Standing Wave

MICROBIOLOGY LABORATORIES

Microbiological Indicators

Methods Development

During 1976 the main thrusts of the Methods Development Unit of the Microbiology Section were the development or modification and laboratory and field evaluation of microbiological, virological, and mycological techniques to assess the quality of water and wastewater as related to health hazards and trophic status. Other studies involving direct problem solving were also carried out. One of these studies, concerning storm runoff waters, was designed to investigate the distribution of pathogenic organisms in storm sewer outfalls, in order to evaluate the feasibility of diverting and treating a specific portion (pathogen-containing waters) of these waters while allowing the other non-pathogen containing waters to reach receiving waters unobstructed and untreated. The results of this study indicated that bacterial pathogens and viruses could be found throughout the duration of a rainfall in these waters, and thus it would not be feasible to divert and treat portions of the runoff.

Laboratory and field studies were primarily concerned with developing in-house expertise in cholera bacteria enumeration, and in evaluation of fecal streptococci enumeration procedures. The suitability of membrane filters for routine microbiological studies was investigated and efforts were made to develop expertise in using bacteria as indicators of toxic and mutagenic substances in effluents and receiving waters. One of the more striking findings of the Methods Development Unit was that presently-used microbiological procedures to evaluate fecal coliform densities in water estimate only 1-40% of the potential waterborne population.

The Microbiology Section contracted four virology studies with Canadian universities. In one of these studies several non-vaccine strains of polio virus were found in the Ottawa River, and, in another, it was found that cancers or virus-induced cancers in fish were directly related to the water to which these fish were endemic.

Water Quality Assessment

The Water Quality Assessment Unit's studies emphasized the use of the zonal grid technique (Figure 23) to identify by microbiological techniques the zone of impact and zone of influence of a point source on a large water body. This technique is a useful alternative to whole-lake monitoring to assess water quality changes.

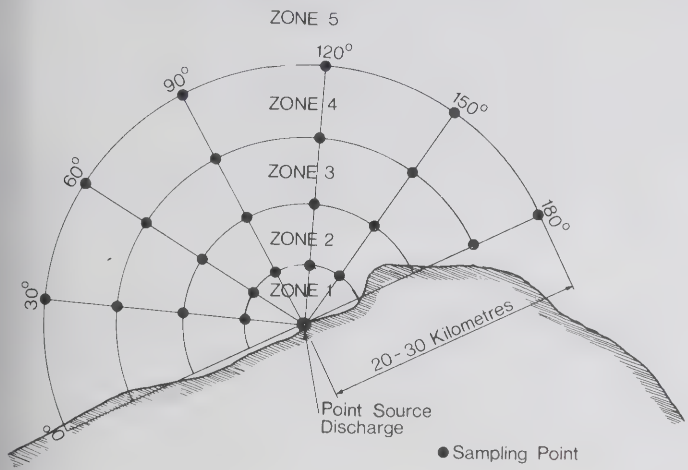


Figure 23 Zonal Grid Sampling Pattern of a Shore Based Point Source Study (General Concept)

Staff of the Water Quality Assessment Unit were also involved in IJC Lower Great Lakes studies which were made up of six surveillance cruises on Lake Ontario where 35 stations were monitored for seven bacteriological parameters and fecal sterols.

During these surveillance cruises, several potential and future problem areas were noted and detailed in a report "Bacteriological Conditions in Lake Ontario, 1976" which was submitted to the IJC Surveillance Subcommittee. These potential and present problem areas will be investigated by future point source studies.

Microbiological staff were also involved in helping draft standard microbiological procedures for the World Health Organization (WHO), International Standards Organization (ISO), and the American Society for testing and Materials (ASTM).

ANALYTICAL METHODS RESEARCH

Advanced Analytical Methods Research and Instrumentation Development

Analytical Biochemistry

Several techniques were developed for the quantification and biodegradability testing of nonionic surfactants including complete degradation by single species of bacteria. Methods were also developed for the measurement of cellular constituents. Collaborative studies included the comparison of three tests for biological activity in sediments of the great lakes and a scanning electron microscopy and microbiological comparison of membrane filters for the MF test.

Atomic Spectroscopy

Development of sensitive techniques for the determination of trace levels of metals in natural water has continued. Work has been centred on the use of the Inductively Coupled Argon Plasma (ICAP) in the multi-element determination of metals by emission spectrometry. A number of separation and pre-concentration techniques have been developed to increase the sensitivity of the ICAP process to the point where it can be used directly for analysis of natural waters.

Studies of the oxidation of organic materials in water have continued, a process for the determination of organic carbon levels in sewage effluents has been developed.

Electroanalytical Techniques

Zero Current Chronopotentiometry - new technique employing ion selective electrodes has been developed. This technique utilizes sensors and gas permeable membranes for measurement in nonequilibrium conditions. Instrumentation, procedure and interpretation of the results are simple and the measurement time is short. Very good sensitivities and selectivities have been achieved.

A rapid, simple, sensitive, and reliable method has been developed for the determination of µg/ℓ ppb levels of chloride in high purity water and heavy water.

Analytical application of the solid state sulfide ion selective electrode was extended to determine various ions at increasingly lower concentrations. It is now possible to use this electrode to measure sulfide, iodide, and cyanide down to 10^{-8} molar.

Electron Microscopy

The facilities of the EM Laboratory have been expanded by incorporation of an X-ray microanalytical system interfaced with both the Scanning and the Transmission electron microscopes. The system is being used for analyses of heavy metals and asbestiform fibres. A method has been developed for positive identification of mercury at ultrastructural level in the presence of sulfur and other interferring spectral components.

GC-GC/MS

The joint project with Canadian Wildlife Service, related to bioaccumulation of pollutants in Lake Ontario herring gulls, eggs, and fish, has involved the identification of a broad spectrum of organic pollutants. Compounds such as polychlorinated biphenyls (PCB), PCB metabolites, organochlorine pesticide residues, their metabolites, polynuclear aromatic hydrocarbons (PAH), chlorinated PAHs, Mirex, photomirex, and chlorinated benzenes have been confirmed by GC/MS.

Significant contributions were made in the development of high performance thermally-stable wall-coated open tubular columns (WCOT) employing gaseous hydrogen fluoride for surface modification.

Research was conducted on characterization of 1, 4-oxathiins employing high resolution mass spectrometry, chemical ionization mass spectrometry, and carbon-13 and proton magnetic resonance.

Luminescence Techniques

An improved method for the determination of Adenosine Triphosphate (ATP) in lake waters, activated sludges, and sediment was developed. This method was found to be superior to existing methods for the analysis of ATP. The improved method for ATP was also used to measure microbial activity in a wide variety of environmental samples. Comparative studies revealed that the improved method provided precise and accurate estimations of living biomass.

Radiochemistry

A study of leaching of naturally occurring radionuclides from uranium mine tailings and settling pond sediments

was undertaken in cooperation with the Environmental Protection Service staff of the Wastewater Technology Centre. Concentrations of ^{226}Ra and ^{210}Pb were measured in leachates from lysimeters containing tailings alone and from others containing tailings with additives to fix the radionuclides.

Tritium reaches Lake Ontario via atmospheric releases of this radionuclide from Pickering nuclear generating station. Precipitation collectors were installed on buoys moored off-shore from the nuclear station and the tritium levels determined in the collected rain water.

A contribution was made to the Department of Fisheries & Environment's submission to Ontario's Royal Commission on Electrical Power Production. Dr. R. W. Durham presented the Department's views on the environmental impact of nuclear power production at the public hearings in November.

The current levels of radionuclides in the open waters of the Great Lakes, and in fish from Lake Ontario were measured. A proposal was submitted for monitoring radioactivity in fresh water sources in the vicinity of the Point LePreau nuclear generating station under construction in New Brunswick.

DATA MANAGEMENT

The Data Management Section is a professional service group, operating across organizational lines and providing leadership and coordination in the vital area of electronic data processing aimed at enhancements and economies in research productivity.

Some of the areas in which significant progress was made during the past year and a list of achievements as they relate to the functional areas to which support is provided by the Data Management group are listed as follows:

<u>Great Lakes Surveillance Program</u>

- All Great Lakes Institute data accumulated at the University of Toronto during the period 1960 to 1970 were accepted into the CCIW archives.

- In accordance with the principals expressed in the Canada/US Water Act, international data exchange systems and procedures for computer based aquatic data were developed and implemented, and data retrievals from the American EPA data storage facilities became routine.

- Criteria were developed for the qualification of Great Lakes Surveillance data. These qualifications criteria were formally approved and implemented including the development of the required software support systems.

- More than 100 requests were received and processed to provide data and other derived information from computer compatible data storage media in various formats.

- A documentation manual was developed to enable the CCIW community of computer users to utilize the electronic data storage and retrieval system called STAR.

Major resources were allocated to provide computer programing and data processing support for CCIW studies. A wide variety of applications programs were developed for user groups, to produce mathematical analyses and tabular or graphic displays using Great Lakes limnological data and oceanographic data files in support of 44 studies spread across organizational lines at the Canada Centre for Inland Waters.

Computer programing and data processing support were also provided in a number of general areas not related to either the Great Lakes surveillance program or the scheduled research studies. Some of the achievements resulting from initiatives undertaken in this area are:

- A final data catalogue was published and distributed covering all of the data acquired under the International Field Year for the Great Lakes.

- A number of major user groups data files were standardized on magnetic tape and securely stored in a centralized fire proof vault.

- Computer based data editing systems using both batch mode operations and on-line systems, allowing for direct human intervention in the editing process, were enhanced.

The Section was also very substantially involved in the process of coordination of departmental data management support services. Advice and guidance were given in a number of critical areas, including a major re-evaluation and plan for updating departmental computing facilities. Advice and guidance were also given in relation to a great variety of scientific and a few major administrative applications for all departmental components housed at the Canada Centre for Inland Waters at Burlington.

SCIENTIFIC ADVICE TO OTHER AGENCIES

In the framework of the Canadian-German Program of Cooperation in Oceanography, Dr. T. J. Simons spent one year at the Institute of Oceanography in Kiel, W. Germany During this time, he participated in the ongoing multi-nationa research program on the Baltic Sea. The main objective was to carry out a mathematical modelling study as a follow-up to the extensive observational program during the spring of 1975 Stratified models developed previously for the Great Lake were found to produce satisfactory simulations of observe currents and mass distributions in the Baltic (Simons, 1976) During this stay in Europe, the same type of model was applie to Lake Constance on the Swiss-German border and Lak Vanern in Sweden. The latter studies were carried out i cooperation with the Water Quality Institute of the Environ mental Protection Agency in Karlsrube, W. Germany, and th Swedish Meteorological and Hydrological Institute in Norrkop ing.

Dr. C. R. Murthy as a UNESCO/UNEP Consultant o Environmental Education undertook missions to Asian and S Asian Countries to assess the needs and priorities on environ mental research and education. He visited Thailand, Malaysi Singapore, Indonesia, Philippines, South Korea, and India an prepared country by country reports to UNESCO/UNEP. H was invited by UNESCO/UNEP to participate and present th consultant mission findings in the International Workshops o Environmental Education, Belgrade, Yugosavia and Pari France.

Dr. Murthy prepared sub-chapters entitled "Charac teristics of Receiving Media-Lakes" and Hydrodynamical Pro cesses - Lakes" for IHP/WHO/UNESCO Monograph "Transport Dispersion and Self-Purification Processes in Rivers, Lake Reservoirs and Estuaries".

Dr. Durham was a member of a committee spo sored by the Ontario Ministry of the Environment to asse current methodology and to recommend the most reliab method for determination of asbestiform fibres in water. consensus was reached on a suitable method after trial of methods on intercomparison samples by committee membe laboratories.

HYDRAULICS RESEARCH DIVISION

The Hydraulics Research Division is part of the :CIW Branch and undertakes research of natural phenomena elated to the physical aspects of water and sediment.

For its objective the Division has interpreted the eneral objective of the Inland Waters Directorate as:

> "To advance, apply and disseminate scientific and engineering knowledge and understanding of all aspects of inland waters for the use of planners, engineers and managers of such resources throughout Canada."

In order to achieve this objective the Division ndertakes national programs in applied and basic research elated to hydraulic, fluid mechanic, geophysic and geologic rocesses as they apply to fluvial, lacustrine and man-made nvironments.

The activities are:

(i) To undertake - directly or by contract - applied and basic research into problems related to environmental processes, the optimum development of resources, the assessment of proposed changes in the environment and the protection of desirable environmental features.

(ii) To develop mathematical models.

(iii) To provide advice, information, technical reports, and expertise on environmental problems for government agencies, for the private sector, and for universities.

(iv) To provide services in the calibration and testing of instruments for clients from government, private, and university sectors.

(v) To undertake - directly or indirectly - scientific and engineering investigations or studies of specific problems brought by clients within the Department of Fisheries and the Environment or other departments.

(vi) To provide and encourage a stimulating environment and facilities for government and university researchers and to disseminate information and research reports and results through publications, seminars, and conferences.

These activities are shared by four operational :ctions.

The Hydraulics Section concentrates on river pro-:sses such as lateral diffusion and sediment transport. Work sediment transport concentrates on model development and ethods of measurement in the field. Studies of ice encompass e jams and the recovery of oil in ice-covered waters. onsiderable work is also done in urban hydrology and the velopment of quantity and quality models. Lastly, studies of ave action and the development of littoral drift and erosion odels are undertaken in the field and in the laboratory.

In the Physical Limnology Section studies relate ainly to lakes, in particular the air/water interaction and the rculation and diffusion of mass and energy in the lake body.

Sedimentology studies by the Physical Sedimento-gy Section relate mainly to the Great Lakes. Baseline studies nearshore sediments as well as geomorphological studies of ore development are included. In addition, geophysical udies of bluff failures are undertaken.

The Technical Services Section, in addition to its technical support service, also operates a National Calibration Service to calibrate current meters for federal govenrment agencies, for provincial government agencies, and for private companies.

HYDRAULICS SECTION

Shore Processes Project

A study was undertaken to develop a mathematical model for the prediction of erosion, deposition and littoral transport in a nearshore zone. A field study at Hamilton Beach has been designed and some preliminary work such as the investigation of wave and current measurement techniques has been done.

At the request of Small Craft Harbours Branch, a model study of Wheatley Harbour on Lake Erie was carried out. This study was to come up with a way and means of improving conditions for navigation at the harbour entrance and for reduction of wave action inside the harbour. The model was constructed in the beach area of the Wind/Wave Flume (Figure 1). As a result of the study, methods for solving the problems in the harbour have been recommended.

Figure 1 Wheatley Harbour Model Under Construction

A study of shore protection in Burlington Bay was conducted for the Hamilton Region Conservation Authority. Model tests were made in the Wind/ Wave flume to determine the size of coarse stones required to form a steep beach which would remain in dynamic equilibrium for wave conditions in the bay.

Some work was done to develop a novel non-permanent shore protection device. It appears that tethered floats may be a feasible answer. Further tests are required to evaluate the performance over a wider frequency range and to determine the mooring forces to counteract the large buoyancy forces.

Ice and Water Interactions Project

The completion of the Phase I part of the frazil ice instrument development project resulted in the construction of an experimental instrument which can quantitatively measure the concentration of frazil ice in water. Such an instrument is needed before any meaningful research concerning frazil ice can be carried out. The experimental instrument has shown that it is capable of measuring frazil ice (Figure 2). Canadian Patent and Development Limited is presently applying for a licence for this instrument. A commercially-manufacturable, improved instrument is now being developed.

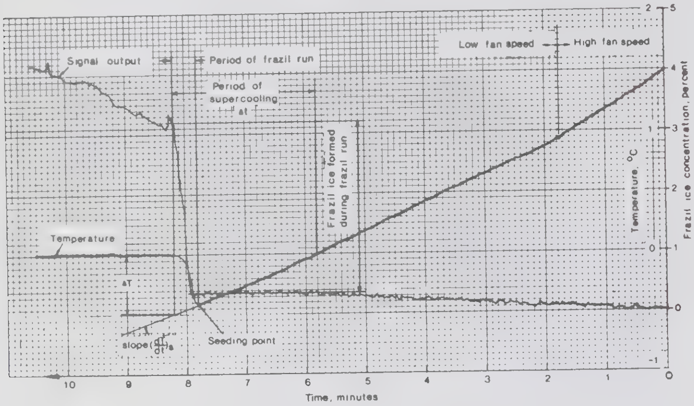


Figure 2 Sample of Frazil Instrument Output

The cold weather hydraulic research facilities, including the cold room and the recirculating flume, have been adjusted, modified, and improved and are completely operational. The facilities are now probably the best in North America.

A study of the jamming of ice and passage of ships through an unconsolidated ice cover is now being completed. Such an ice jam caused a 30 percent power shortage in Montreal in the Christmas period of 1976. This project was initiated following the above incident to help Hydro-Quebec solve their operational problems and to answer the question of when a ship may or may not pass an ice cover on a canal leading to a hydro station.

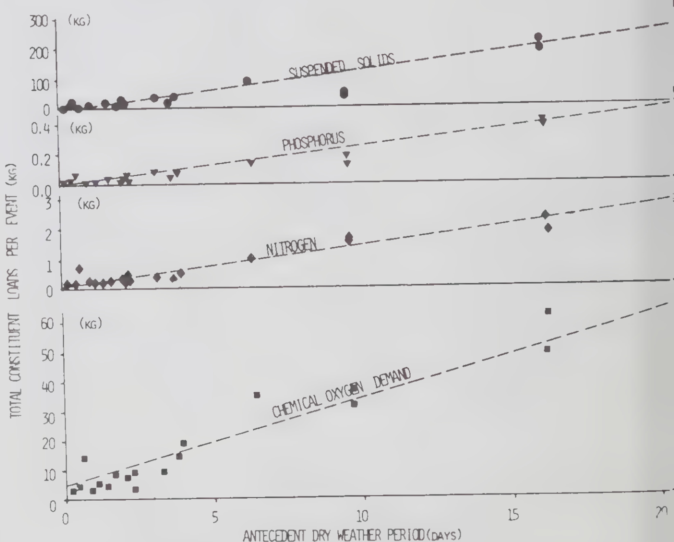
An ice-oil boom development project which had been initiated earlier but was deferred due to a manpower shortage, was re-initiated early in 1977. Presently the theoretical study has been completed and laboratory work was partially done. A cooperative effort is being maintained with the U.S. Coast Guard who are now building a prototype boom based on our theoretical and laboratory work. The boom will be jointly tested when completed some time in 1977. The ice boom is aimed at separating ice flow and oil in ice-infested flowing water prior to oil containment and recovery by conventional methods.

Urban Water Systems Project

A number of studies have been undertaken in support of the Canada-Ontario Agreement on Great Lakes Water Quality. A contract study to produce a Canadian version of the Storm Water Management Model (SWMM) of the U.S. Environmental Agency has been completed. The study also involved the Environmental Protection Service (EPS) and the Ministry of the Environment (MOE). The newly-developed version of the SWMM model accounts for Canadian climate, economy, and environmental concerns. In cooperation with the aforementione government groups, the study was concluded by extensiv technology transfer activities. Two workshops on the applicc tion of the SWMM model were successfully held in Toronto i 1976. Both workshops were over-subscribed which indicate great interest in innovative approaches to urban drainage.

In other technology transfer activities th Hydraulics Research Division contributed to the organizatic and technical program of the conference on Modern Concep for Urban Drainage held in Toronto in March, 1977. Th program contributions consisted of the writing of a majc chapter on "Characterization of Flows in Urban Drainac Systems" for the MANUAL OF PRACTICE ON URBAN DRAIN AGE distributed at the conference and also the preparing of c invited paper on "Data Collection, Instrumentation and Verifi ation of Models".

While significant advances have been achieved modelling quantities of urban runoff, the simulations of runo quality with the existing models - including the SWMM model appear to be unsatisfactory. Further testing and refinement the runoff quality models is impaired by the lack of adequa data. Consequently, the Hydraulics Research Division co tinued its urban data collection program, concentrating on tl collection of data on runoff quality. Runoff quality has be monitored on the Burlington Test Catchment for a number events and a preliminary analysis of these data has be completed. The duration of the dry period prior to the stor appears to be the primary controlling factor for the tot pollutant loads in storm water leaving the catchment. T observed relationships, total pollutant load (per event) antecedent dry weather period, are shown in Figure 3. The da collection program will continue to expand the present da base.



TOTAL CONSTITUENT LOADS vs. ANTECEDENT DRY WEATHER PERIOD

Figure 3 Urban Water Systems

To obtain quantity and quality data for flows combined sewers a contract to collect such data on Hamilton Test Catchment has been extended. The observati indicate large variations in the strength of combined sew during both wet and dry weather periods.

Current sophisticated computer models for f routing in sewer networks require knowledge of energy losses sewer junctions. Experimental data on these losses are v scarce. Consequently, an experimental study of energy los at sewer junctions has been undertaken. So far, the testinc straight-flow-through junctions has been completed for selec geometries and a large range of flows and pipe slopes. tests will continue by testing more complicated junc structures.

To facilitate and accelerate the international exchange of expertise in the field or urban hdyrology the United Nations Educational, Scientific and Cultural Organization (UNESCO) initiated a series of national surveys of the state of the art in urban hydrology. The Hydraulics Research Division was requested to undertake such a survey in Canada. The study has been completed and a final report submitted to UNESCO and widely distributed in Canada.

River Processes and Fluid Dynamics Project

The development of a mathematical model for predicting the response of rivers to artificial or natural changes in the flow hydrograph, sediment input, etc. was completed. Some experiments have been conducted in the 2 m flume to calibrate and verify the model.

A study on the effect of meanders on transverse mixing was completed with the aid of some novel experiments which included the variation of bed topography caused by the meanders. Some experiments to study the formation of meanders were conducted on a sloping platform and will be continuing.

Laboratory investigation of the effect of bottom roughness and width-depth ratio on transverse mixing in open channels was successfully completed. It revealed that the commonly used mixing coefficient is inadequate for the description of transverse mixing because the effect of secondary circulation has not been accounted for. A new dimensionless mixing coefficient was introduced. As shown in Figure 4, the effects of width-depth ratio and friction factor are clearly identified. Existing data also correlate very well on this plot. These studies on transverse mixing will aid the prediction of concentration levels of pollutants and other materials in natural channels.

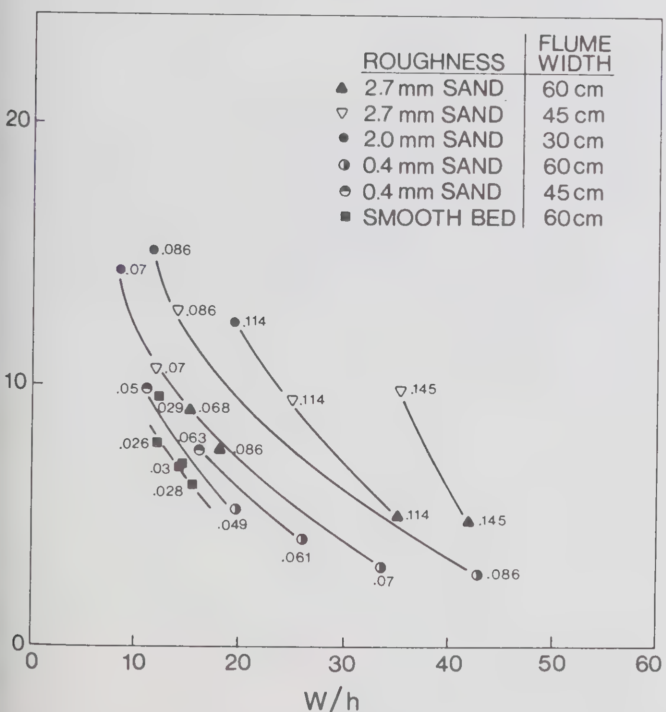


Figure 4 Effect of Width-Depth Ratio and Friction Factor on Dispersion Coefficient

A hydraulic model study of two proposed flow control structures for the Richelieu River in Quebec was carried out at the request of Water Planning and Management Branch, IWD. As a result, design changes to minimize scour have been suggested.

Experiments on the measurement of bed-load discharge by the charting of dune movement have been completed. This study will provide answers as to the feasibility of measuring bed-load by using newly-developed radar equipment as proposed by Sediment Survey of Canada.

The use of tritium as a tracer for measuring evaporation from rivers was studied in a small wind tunnel and the results indicated that further studies are needed to make it a feasible method.

PHYSICAL LIMNOLOGY SECTION

Physical Processes in Lakes Project

Two major reports summarizing IFYGL projects on energy balance and wave movements were completed this year and are currently in press (see Boyce, Moody and Killins, 1977, and Boyce and Mortimer, 1977). These two documents will provide easy access to a large body of data of interest to lake modellers.

Analysis of detailed water temperature data collected off Oshawa in 1970 has been completed, thus adding to the large and growing literature on the complex behaviour of the coastal zone of large lakes (Boyce, 1977). (See Figure 5). This analysis shows the existence of meanders and isolated warm and cold patches in the vicinity of an upwelled thermocline. This study confirms suspicions that exchanges of material between the nearshore zone and the open lake are highly episodic and cannot be adequately described in terms of existing theories or parameterizations. The eventual synthesis of coastal exchange processes - a matter of great importance to Great Lakes management - will require continued experimental and analytical effort.

During the past year field studies of wind-generated waves especially the process of breaking in deep water - whitecapping have been undertaken. To this end a tower was erected at the western end of Lake Ontario (see report of Scientific Support Division). The tower, expressly designed for measurements of wind and waves, produces relatively little interference and supports about three dozen instruments, continuously and automatically recorded in a trailer on shore 1100 metres away. So far a wealth of data under a variety of conditions has been collected. Analyses are being carried out by the staff and through a contract with the University of Waterloo to the following ends:

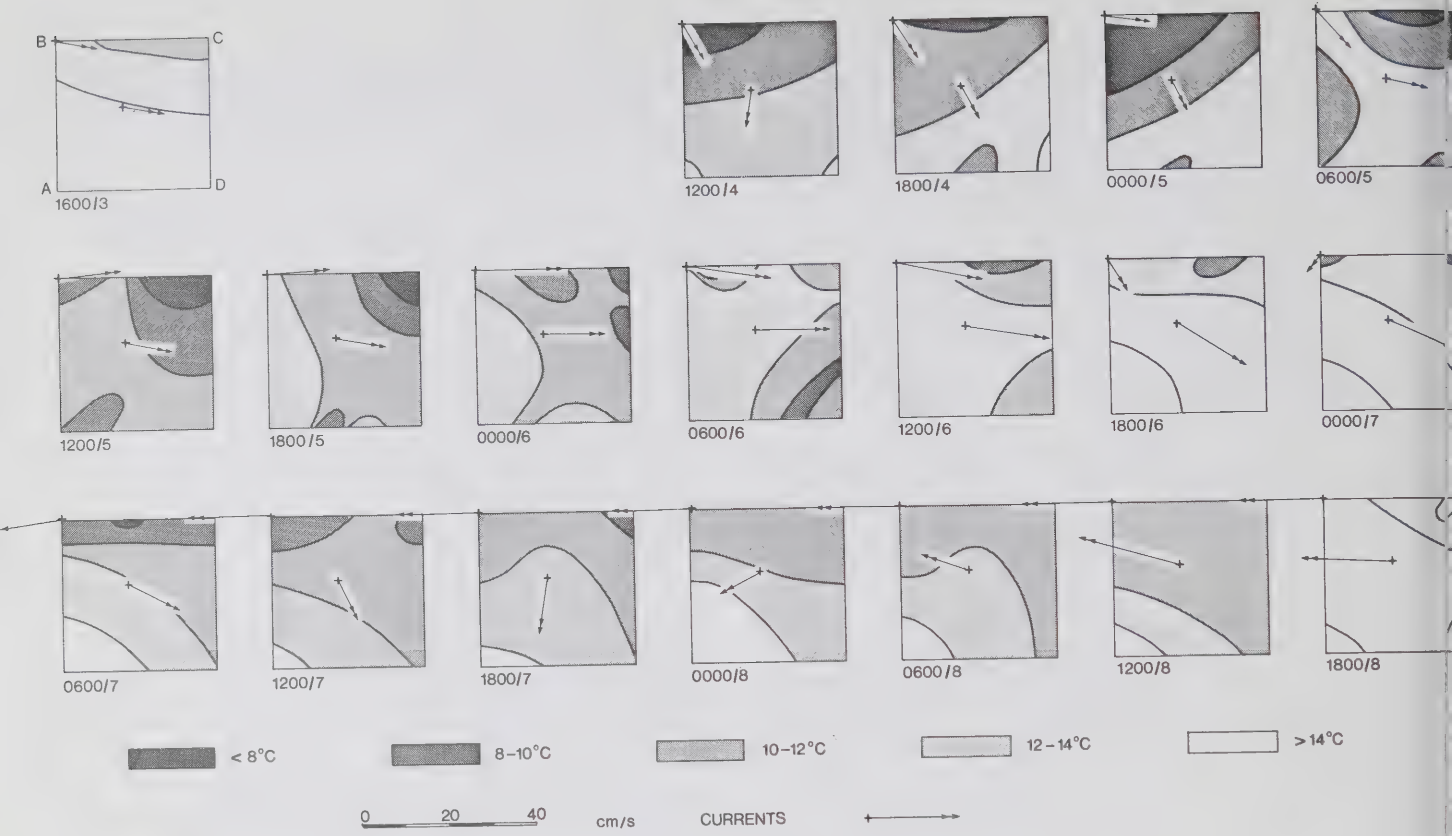
(a) To investigate the development of the directional spectrum of waves and to relate it to fetch and wind variability;

(b) To investigate the effect of "sea-state" on the air/water transfers of momentum, heat and moisture;

(c) To determine the distribution of velocity fluctuations and momentum transfer with depth beneath breaking waves.

In order to acquire the data necessary to achieve (c) a special probe (Figure 6) was built under contract to the University of Toronto. The tiny probe, known as a "drag sphere velocimeter", measures the components of drag force on the sphere due to the flow of water past it.

During the analysis of the wave data it was noted that wind-waves have extraordinarily persistent self-correlation functions. In Figure 7 waves having an average period of 2.2 seconds and group length of about 20 seconds show significant self-correlation to time lags of 200 seconds or more, although the self-correlation has been averaged over 1800 seconds. The practical consequences of this in dealing with waves and their interaction with man and his environment are being investigated.



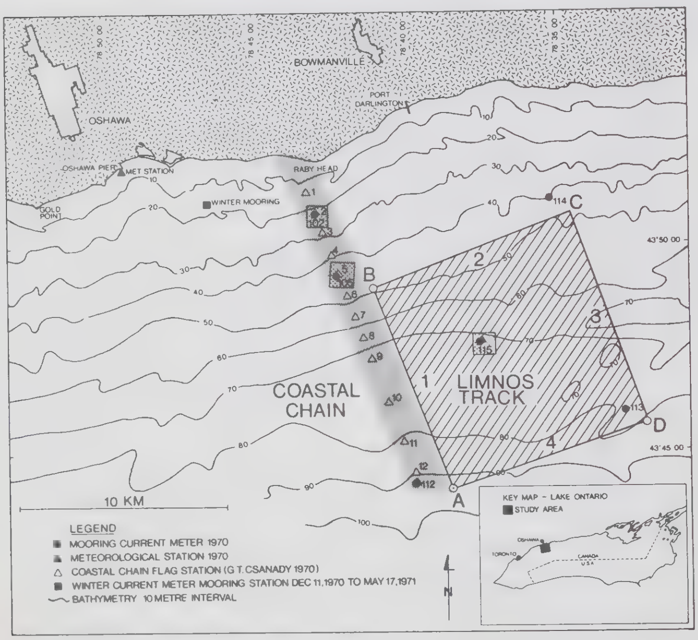


Figure 5 Physical Processes in Lakes

Synoptic maps of surface temperature at six-hour intervals across a 10 km square defined by the track of CSS LIMNOS. Line BC lies along the 50 m depth contour located approximately 5 km offshore from Raby Head (near Oshawa on the north shore of Lake Ontario). Near surface currents at two moore instruments are also depicted. The figure depicts an upwelling, current reversal, and subsequent downwelling in response to a strong westerly wind pulse centred on October 3, 1970. An alongshore "waviness" of surface isotherms together with evidence of isolated pools of warm and cool water are the interesting features of this diagram.

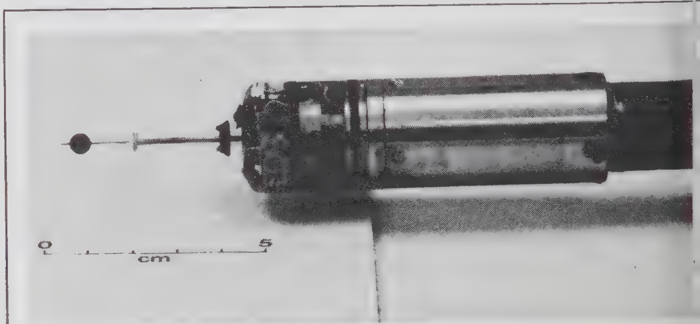


Figure 6 The Miniature Drag Sphere Velocimeter

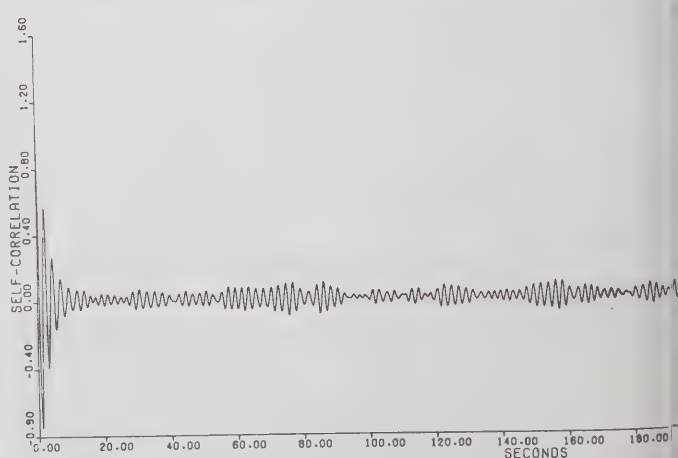


Figure 7 The Self-Correlation Function of Natural Wind-Generated Waves

ʼhore Processes Project

Coastal Sediment Budget, central shore of Lake Erie: A CCIW Jnpublished Report was prepared for the nearshore zone of ‑ake Erie from Port Burwell to Point Pelee. The report ›rovides basic data on nearshore materials and an analysis of ʼhe relationship of source materials, nearshore transport, and ;ites of sediment accumulation. It responds to the need for a lata base for coastal planning, shoreline development, and oil-pill contingency planning. Key findings include an independent ›stimate of littoral transport rates at Point Pelee, based on ›rosion-accumulation rates, and the recognition that there is a equence of sediment textural patterns, which appears to eflect change in the mode of sediment transport, and which nay be useful in mapping areas dominated by traction, altation, or suspension transport.

ʼhotologger observations of coastal sediment response to torms: This is a study which makes use of a sophisticated nderwater time-lapse camera system for observation of bot-om disturbance and sediment transport associated with storm onditions. Initial trials of the system at Burlington in the pring of 1976 recorded storm-induced accumulation rates as igh as 30 cm/day in water depths of 8 m. These exceed by two rders of magnitude the long-term rates measured by pollen-ating and demonstrate the importance of documenting the nort-term episodic changes of the nearshore zone as input for a nodel of coastal zone response to change.

learshore stratigraphic studies: Stratigraphy of nearshore ediment cores is being analysed in order to determine the ariation in the rate and type of postglacial sedimentation and s dependence on short and long-term water level change. The ntent is to apply past rates of coastal evolution to the rediction of future change.

Preliminary studies have been concerned with the neasurement of shallow-water sedimentation rates by pollen ating. A simple procedure has been devised to raise the oncentration of pollen in sand-rich cores to levels adequate for nalysis. Useable profiles have been obtained in Lake Ontario earshore cores which indicate that recent sedimentation rates re slightly higher than those of adjacent basin sediments and wo to four times higher than the long-term rates.

The Bluffer's Park landfill project at Scarborough is eing used as a test case of the effect of toe protection on ıture slope evolution. Two profiles, one with toe protection nd one without, were established in the fall of 1975 and ›surveyed in March and September of 1976. Observations to ate indicate that the middle and upper slopes are essentially naffected by change at the toe, that the bluff crest is receding the result of undercutting by seepage and piping, and that nallow debris slides are accumulating at the toe of the cliffs nd affecting the slope drainage. These short-term results are be supplemented by aerial photographic evidence for the ›riod 1947-76 to indicate natural changes occurring on the me scale of decades.

At Port Burwell a study is underway to identify and vestigate bluff failure mechanisms, to establish the spatial d temporal variability of morphologic changes within the ıdy area, and to contribute to the development of a otechnical classification of shorelines useful for coastal anning. In 1976-77 field work consisted of continued onitoring of subsurface movements, and ground water and re pressure fluctuations, and of detailed resurvey of the study e. The survey results show the rapid development of small llies in the western part of the area and the relative stability a larger mature gully at the eastern boundary. Recession tes of the bluff crests range from 0-60 m with an average of 8 Changes at lake level range from 4 m of accretion to 38 m erosion. Net volumetric loss from the 850 m stretch of orebluff is approximately 100,000 m^3.

Primary failure mechanisms at the study site are gully formation and rotational slips. Geotechnical testing of the bluff materials at CCIW and under contract is being used to provide the input for slope stability analysis and to determine the relative importance of the geotechnical parameters.

Contract reports have been prepared on the development of a geotechnical shoreline classification, shear testing and clay mineralogy at Port Stanley and Iona, and the dependence of bluff failure on strain-softening of cohesive sediments.

In 1976 the nearshore sediment survey moved into Lake Huron and completed the mapping of the nearshore zone between Sarnia and Goderich. A data report which includes some preliminary analysis of data is near completion.

Bottom types identified by the survey are shown in Figure 8. Glacial deposits (till and glaciolacustrine sediment) predominate; modern sediment is concentrated in two deposits - inshore at Kettle Point and offshore at Sarnia; bedrock, the minor component, is exposed only at Kettle Point.

The origin of the offshore sand deposit at Sarnia is uncertain. It may represent a relict littoral deposit associated with a lower lake level but this has yet to be confirmed. The Kettle Point sands appear to be a modern littoral deposit developed by entrapment behind Kettle Point of southward-moving littoral drift derived from bluff and slope erosion and stream discharge along the coast to the north.

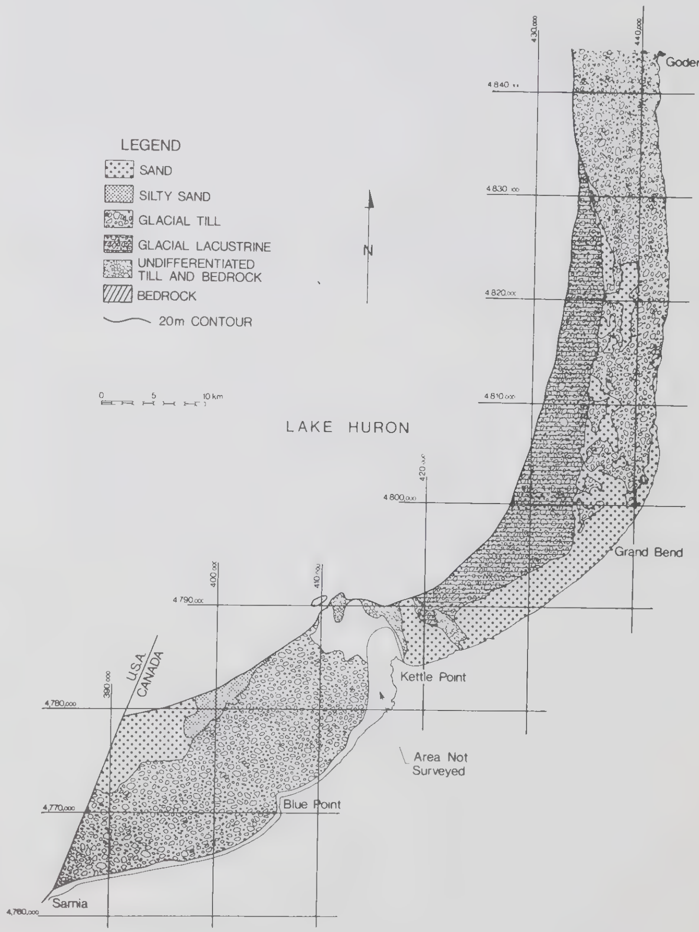


Figure 8 Distribution of Nearshore Bottom Types - Sarnia to Goderich

Workshop on Great Lakes Coastal Erosion and Sedimentation: The Physical Sedimentology Section hosted a Coastal Workshop on November 29, 30, 1976 which involved a program of research summaries, poster discussions, and chaired discussion of four key coastal research topics. The research summaries, introductory papers on the research topics, and discussion summaries have been published as a Workshop Proceedings.

A study of Point Pelee was completed in fiscal year 1976 with the publication of the final report on processes in sediment deposition and shoreline changes in the Point Pelee area. A synthesis of the results of several interdisciplinary field and laboratory programs served to quantify many of the important parameters in littoral transport, sedimentation rates and modes on the shoal, and on-going evolutionary shoreline changes. Rates of littoral transport were found to be small (less than 25,000 $m^3 yr^{-1}$) compared to areas such as Long Point, and were variable in direction, the net directions being southward on the east side and northward on the west. On the shoal south of the Point, the net direction of sediment transport was concluded to be toward the east at undetermined rates under the influence of unidirectional processes related to lake circulation. The shoal morphology and sediments appear to be features associated with sedimentation processes which prevailed at an earlier stage in the post-glacial history of the area. These features are presently being modified and redistributed by modern processes with little additional input of sediments.

Shoreline changes consist, for the most part, of net erosion of the east side and stability or net accretion of the west side. Although these changes are clearly linked to evolutionary trends traceable since the formation of Point Pelee some 4000 years ago, there are signs that man-induced effects play a significant role. One of these effects - that associated with sand mining of littoral sands and gravels - is seen as having been a major factor in shoreline changes near the tip of the Point when such operations commenced early in the present century. The effects of the more recent operations restricted to the shoal area could not be defined exactly, but in the light of the processes and sediment transport patterns observed, the possibility of adverse effects still cannot be excluded.

Physical Sedimentology Manual: This is a continuing project to develop a manual of the field and laboratory procedures used at CCIW in sedimentological and geotechnical research. It responds to a need for a standard reference manual for internal and external use.

During 1976-77 an outline of the topics to be discussed was prepared and work was begun on the section on size analysis procedures. Considerable time was spent in developing a consistent and theoretically sound approach for the several analysis methods which singly or in combination provide for the range of sediment types processed by the lab. The computer program SIZDIST which reduces the raw size data to summary statistics was expanded to handle the full range of procedures and revised to match the output statistics to the level of the inout data. A final draft of the section on size analysis is now complete and ready for editing.

TECHNICAL SERVICES SECTION

This section has three major functions:

1. The general supervision and upkeep of the Hydraulics Research Laboratory;

2. The provision of technical support to the Hydraulics and Physical Limnology Sections to assist scientists and engineers with their research studies;

3. The National Calibration Service which involves the calibration and testing of current meters and other hydrometric equipment in the tow tank and the cold environment testing chamber.

1. The general upkeep of the laboratory is provided through the operation of a "light" machine shop, an electronics shop, and a carpentry shop. The services of qualified tradesmen are extended to the researchers to assist them with the setting up, repair, and maintenance of equipment used for research studies.

2. Technical support is provided by ten research technicians who are assigned to studies under the guidance of the engineer or scientist in charge. Their tasks consist of the setting up of experiments, collecting, evaluating and analyzing data, designing, plotting graphs, and writing technical reports.

3. National Calibration Service: the demand for the calibration of hydrometric equipment increases each year. (See Table I.) The change-over by Water Survey of Canada to the use of metric equipment has involved much testing and some designing. Metric calibration certificates are now available upon request.

Table I Calibration of Meters for 1976/77 Distributed by Agency

Agency	Number of Meters
Water Survey of Canada	591
CCIW	40
Other Federal agencies	16
Provincial agencies	98
Universities	15
Private sector	20
Special tests	48
Total	828

Low Temperature Testing

Facilities are available to test equipment under simulated cold climate conditions. These have been extensively used to test the Geodyne current meters for low temerature operations. Water Survey of Canada is expressing interest in having their water level records tested.

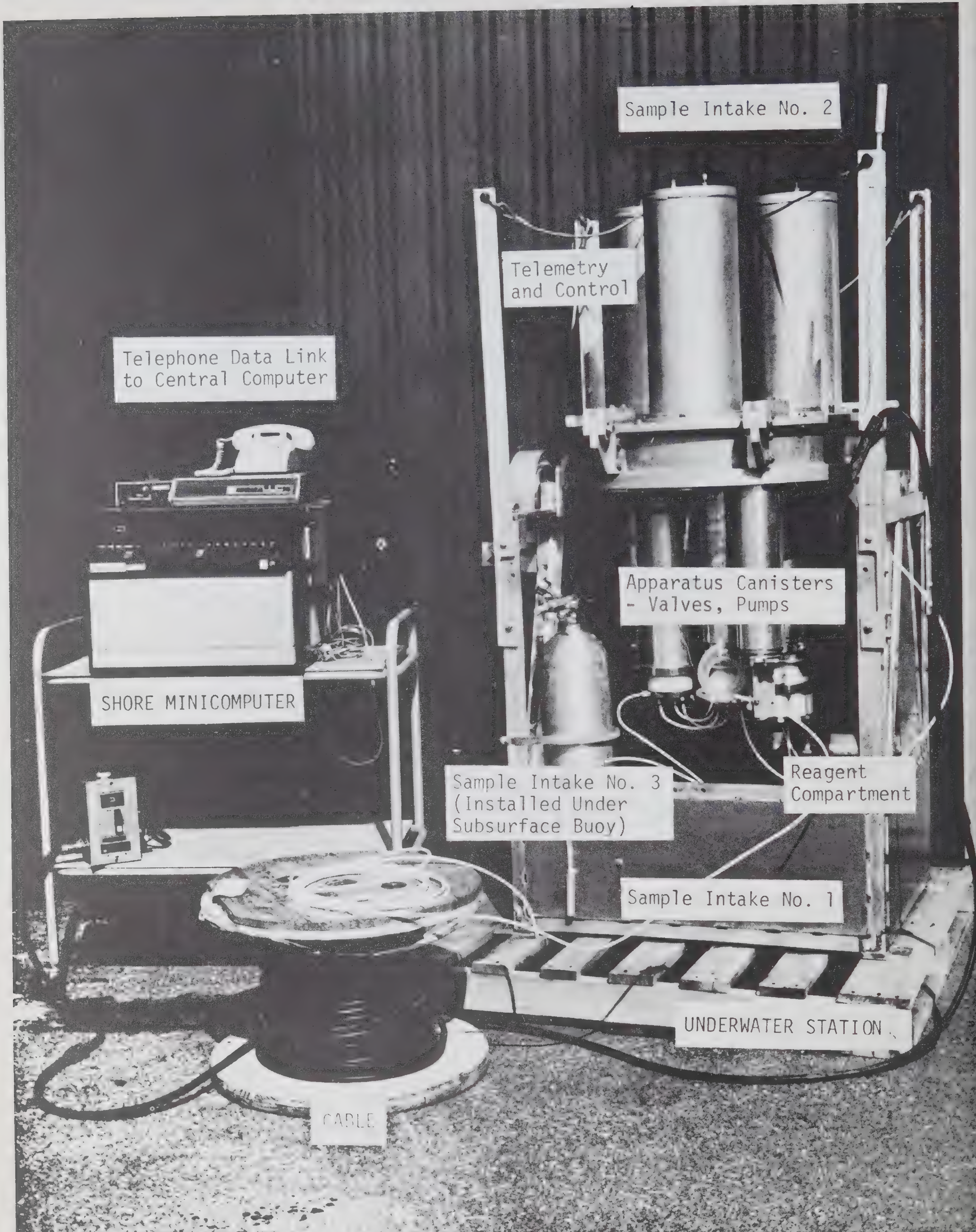
Special Tests

Special tow tank tests were conducted for the mechanical design section of Bedford Institute of Oceanography in Dartmouth, N. S. involving five B-10 Braincon deep ocean buoys. Tests were run to determine:

a) Drag force as a function of velocity
b) Behaviour on current reversal
c) Buoy stability at all velocities
d) Required modifications to increase stability.

Several tests were also conducted for the Engineering Services Section and the Division's Engineering scientific support involving modifications to towed bodies to increase their instrument carrying capabilities. Other tests were also run on underwater camera equipment.

SCIENTIFIC SUPPORT DIVISION



ROBOT EXPERIMENTER SYSTEM

The Scientific Support Division is responsible for providing the professional and technical support for the research and survey programs of the Branch, as well as some of the common services provided to other agencies of the Department at the Centre. These services are provided by sections and units which make up the Division and their accomplishments for the year are detailed in the following paragraphs. In brief, they consist of,

(a) the development of new instrumentation or equipment to satisfy a specific requirement, normally needed by more than one user.

(b) the improvement by modification of existing equipment to increase the performance, reliability or to perform a special function.

(c) the maintenance, calibration and servicing of electronic and mechanical equipment in common use throughout the Centre, and in some other regions by staff from the Branch.

(d) the technical and logistical support for the multidisciplinary field and ship operations and scientific projects.

(e) the provision of the major computing hardware, system software, ancillary equipment, and the operation of this equipment in the data centre.

(f) the provision of a reference library and information retrieval services.

TECHNOLOGY DEVELOPMENT

Some of the development projects undertaken by the Division during the year were,

Vertical Automatic Profiling System

The system prototype is essentially a winch on the bottom of a lake controlled and powered from shore about one kilometre away. The winch repeatedly cycles a floating body through the water column. The body carries an array of instruments such as current meters and temperature sensors. At the end of the year, the system underwent trials in preparation for use in Kootenay Lake, B.C. Major benefits from the system are high spatial resolution of scientific data with low capital expenditure for instruments.

Forces on Towers

The forces of water waves impinging on tower legs produce stresses in the tower structure. These stresses are predicted by nodal analysis made possible through modern computer techniques. The data on real strain have been gathered and the comparisons with the predictions are in the final stages of preparation for publication. Use of such computer programs is becoming prevalent in engineering, and therefore must be verified by experiment.

Active Towbody System

As part of development of a general-purpose, towed-vehicle system, a "Batfish" body has been expanded, tow tested, and the system mathematically modelled for predictability. As a demonstration of the capability of the system, a pumped sampling system was installed and flown in the vehicle utilizing a novel high pressure pump that delivered nine litres per minute through the 215 metre, non-contaminating, electro-hydro-mechanical faired cable, without serious degradation of plankton or smearing of water samples. On-board sensors monitored depth and vehicle status as the body undulated between the surface and 55 m depth with a 0.7 km cycle at 10 kts towing speed.

REX (Robot Experimenter)

The Instrumentation R&D Unit has been developing and field testing the 'Robot Experimenter', a comprehensive instrument system for conducting in situ experiments and water quality analyses. Basically, it is a submersible robot laboratory which can be placed in a lake or river to collect time series data, unattended for a long period of time. It consists of a main frame which houses electronics modules and apparatus modules. The apparatus modules include pumps, valves, reagent reservoirs, electrodes, sensors and other items which have been specially developed so that this system will have many of the facilities of an analytical laboratory for handling reagents, processing samples and taking readings. The electronics modules provide control and data acquisition.

This robot laboratory is operated by a small minicomputer, housed on shore, which communicates with the robot laboratory via an underwater cable. Its software package allows a user to program his analysis alogrithms in a high level language written especially for this facility. A basic library of programs has been written to control the various apparatus modules and to perform analysis for nine water quality parameters (temperature, pH, conductance, dissolved oxygen, redox potential, chloride ion, by direct electro-chemical techniques; total alkalinity and total carbon dioxide by in situ titration; and suspended solids by absoption and scattering of white light). The minicomputer is normally operated unattended, executing sample-and-analyze programs on a pre-scheduled basis, usually once per hour. It can communicate with a large computer facility at CCIW over the telephone, thereby allowing data to be retrieved, processed and examined in near real time, as well as allowing program changes to be made to suit the conditions at the time.

Field trials in Hamilton Harbour and in a test tank have proven the computer and underwater laboratory with all its apparatus modules. The repertoire of analysis programs has been developed to a useful level for all measurements. Work is still progressing on optimizing the detailed considerations of time, chemical conditioning and signal processing which are best for each measurement analysis. Also, a variety of techniques are being evaluated for in situ standardization or verification of each.

It is expected that this one REX system will be used in projects where time-series data of water quality parameters are thought to be important. It should advance the state-of-the-art for observing in situ water quality parameters and provide data base from which we can determine those having significance for automated monitoring networks and what the best techniques are for observing them. Because of its modular design and high level software, it should be able to be adapted to a series of such projects. Where networks of multiparameter monitoring stations are required, many of the modules and techniques developed here can be deployed in smaller, optimized main frame assemblies which should have installed operating and system costs lower than present commercial systems.

D. O. Sensor

Other work is pursuing the development of a new type of dissolved oxygen sensor with potential to be capable of long term in situ operation. Based on the membrane-protected, semi-integral electroanalysis devices prototyped in the laboratory by Dr. K. B. Oldham (Contract, 1973), the development work has concentrated on achieving a manufacturable design which will deliver the desired characteristics in the field.

TECHNICAL SUPPORT AND SERVICES

The technical support provided varied considerably throughout the year, however, 16 specific items have been selected as being representative of the services provided. The last on the list, the WAVES Facility, is featured because it is one of the most ambitious of the projects undertaken since the CCIW came into being.

Acoustic-Anemometer Remote-Control Facilities

The ultrasonic-anemometer is a well known instrument for measuring air velocity turbulence. This device is in use at CCIW. For the 1976 WAVES study it was necessary to have automated remote-control over the instrument which is normally controlled manually. This was achieved by using digital-controlled relays and switched resistor ladders. The digital control is derived from the main control system which is based on a mini computer.

Acoustic Water Velocity Sensors

CCIW Engineering Services evaluated an acoustic sensor for measuring water-currents. Although such devices exist in one, two, or three axis form, work done to date has been based on the two-axis sensor. The most advantageous application of these sensors at CCIW is the measurement of very low, lake-bottom currents of the order of several millimeters per second, which is below the threshold of more conventional current meters. Some custom improvements were incorporated to enhance the meter's characteristics.

Automatic Pumping Water Sampler System

This system is used for year-round, unattended collecting and bottling of samples of water, pumped from a fixed point in a river or lake. Contamination of each discrete water sample is avoided by having the sample water pumped for an adjustable period of time before the sample is taken so that no residual water from a previous sample can remain in the supply line. At the Wolfe Island location at Kingston, Ontario, the major system components (including the pump) are all housed on shore in a heated shed. For winter operation, the exposed inlet line has an anti-icing system using externally applied heat tape, plus insulation.

Epilimnion Nutrient Settling Fluxes System in Lake St. George

The aim of this project is to measure the vertical flux of particulate carbon, nitrogen and phosphate from and to the epilimnion of a small lake. The system uses special settling chambers for sampling in a lake. In operation the chambers, with end caps and shutters open, are lowered into the lake vertically on a taut line. The end caps are then closed and the sedimentation within the samplers allowed to continue for several hours. Immediately before lifting the samplers from the lake, the shutters are actuated to trap the sediments within subsections in the cylinder. From the amount of sediment filtered from the contents of water in the top and bottom sub sections of each sampler, it is possible to calculate the net settling flux.

A Fast-Response Acoustic Time Varied Gain Receiver for Fish-Census Studies

Earlier CCIW biological studies on fish-populations in the Great Lakes had experienced inadequate accuracy and speed-of-response in the electro-acoustic receivers used for target detection in these shallow waters. This problem was eliminated with the development and incorporation of a high-performance time varied gain (TVG) receiver assembly, which accurately compensated for spreading losses in the water column.

Lake Bottom Water Sampler

A special sampler has been designed to simultc neously collect 30 water samples up to two metres above th lake bottom. The design consists of a pyramid structure whic supports an array of plastic syringes. After lowering the arrc to the bottom, a mechanical messenger is sent to release trigger plate which then falls and simultaneously trips all of th syringes so that their plungers can be actuated by preloade springs. The sampler is then pulled to the surface for unloadin

Launch Trawl Equipment

The Great Lakes Biological Laboratory required launch with trawling capability for the gathering of fish in th midwater region. This was to check the species and sizes fish in each area to verify a prototype acoustic fish-censusir system which was being evaluated. The launch 'Aqua' w modified by the addition of a trawl winch system consisting two commercial trawl winches and a complete hydraulic syste adapted to an existing diesel unit. Calculations showed that th aluminum hull launch could roll over in a tight turn if the ne should snag. Special safety links were placed in the trawl li to eliminate this potential problem.

Mass Spectrometer Additions

The Hitachi Perkin-Elmer RM6-62 is an aging b expensive mass spectrometer. Some electronic portions we not up to present day performance and reliability standarc Several items have been installed to remedy this problem.

Microbiology Pressure Chamber

A system was produced to contain a bacter solution to be kept at a constant pressure which corresponds the bottom conditions of an inland lake. Samples of three five cubic centimetres were required to be taken from t chamber while still under ambient pressure. A rubber d separated the pressurizing fluid from the solution under stu The samples were drawn through an hypodermic needle septur

Optical Radiation Sources for Lake-Column Simu tors

The CCIW array of eight in-house "lake-colu simulators" (large experimental water columns) is used as a t by the GLBL staff in the study of biomagnification of toxican To provide better simulation of natural conditions in the water columns, it was required that the artificial light sourc be improved in intensity and spectral content. During 1976 necessary design procurement action, installation and test these radiation sources was completed and found satisfactory

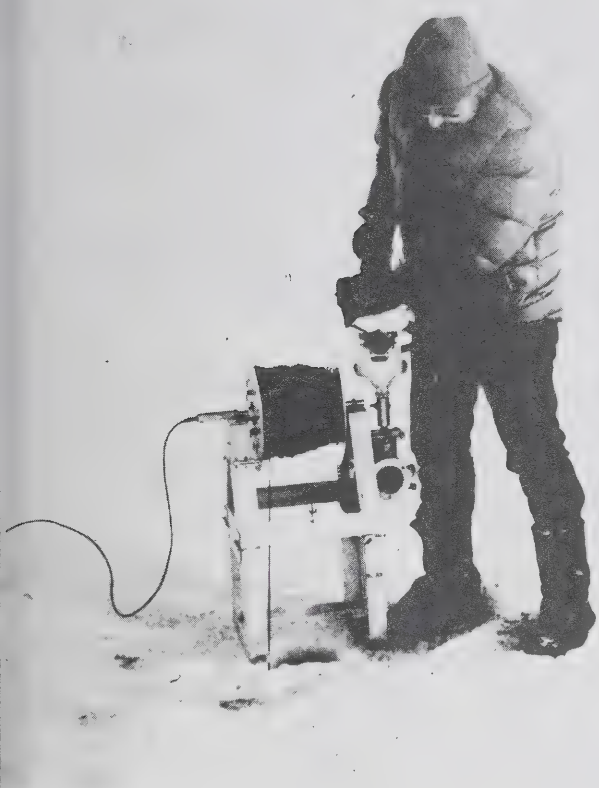
Photochemical Process Apparatus

A special apparatus has been designed and manuf tured for measuring the breakdown of organic compounds i lake due to light. The apparatus consists of a plate to hold flasks, containing sample lake water and chemicals. The pl is lowered to a specific depth and secured to a surface fl which is left in place for several weeks. At the end of e period, a cone is lowered down the mooring line to cover sample bottles so that the entire assembly is retrieved i light-tight condition. The assembly is then put into a light-t box where the sample is transferred from each flask int special transportation box.

Portable Arctic Winch

A special small, light, portable winch has b designed and built for use in the arctic and is intended lar for through-the-ice handling of instruments with minin physical exertion. Its base can be folded for stowing in a Ranger 206 helicopter. In normal operation, the hole is bore the ice with a commercial ice auger, then the motor is detac and transferred to the winch to be its prime mover. The se

package and cable is lowered through the water column by controlled free fall and raised again by the winch. The winch can also be hand operated in an emergency. To reduce overall size, a special slip-ring unit has been designed to fit inside the winch drum.



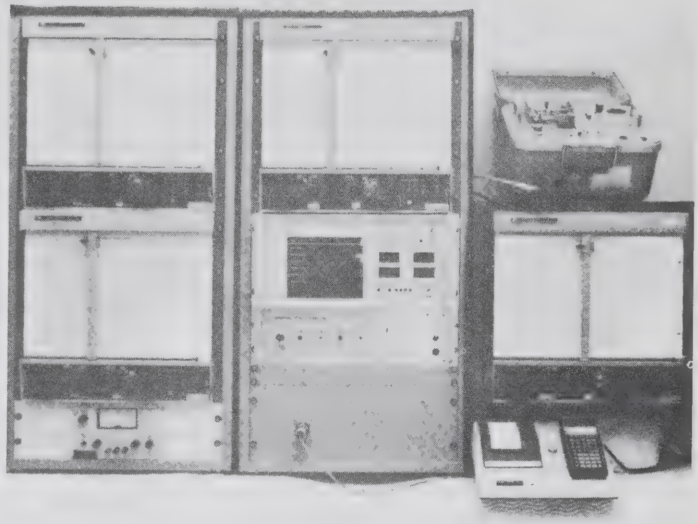
Portable Arctic Winch being used for Profiling in Hudson's Bay Area by OAS Personnel

Recirculating Ice Flume

A recirculating ice flume was designed at CCIW to corporate several features required to allow study of ice over formation, ice cover stability, oil/ice/ water/air interacon, and related matters in open channel flow. The flume is inalled inside a CCIW Cold-Room. The working section is quipped with electrically heated windows and side walls to ontrol ice formation and water temperature. The water ooling is achieved through the channel's air-water interface ing the cold-room air, assisted by the wind tunnel fan. The ump casing, circulation piping and water storage tank are sulated to maintain steady water temperature.

Turbidity/Temperature/Conductivity Profiler

This system was developed for the 1976 Kootenay ike study program. It suits launch operation and portable nerator power sources. Vertical-profiling of lake turbidity, mperature, and conductivity are achieved through high quality nsors. Data are presented both directly (on analog chart corders) and logged digitally on magtape. By the end of 1976 any thousands of profiles had been taken at the 50 measureent stations on Kootenay Lake, using this system.



Kootenay Lake Turbidity/Temperature/Conductivity Profiler

Water Conductivity and Temperature Calibration Bath

This system was specified by CCIW and constructed by a Canadian manufacturer. It uses a powerful pump and fast heat exchanger to achieve temperature stabilities better than other commercial units at twice this one's cost. The very large table-top area is designed to conveniently support the in situ water quality packages for calibration.

WAVES Facility

The Water-Air Vertical Exchange Study required a very elaborate array of stable transducers and sensors such as wave staffs and anemometers. A tower was designed and contracted for construction and installation off Burlington Beach near Hamilton, Ontario. All data are gathered and transmitted ashore by a sophisticated small computer based subsystem. Several man-years and about one quarter of a million dollars were invested in this facility which is finding wider application in research, along with the prime use for which it was intended.

WAVES - 76 Platform with Instrumentation

The extensive instrumentation maintenance and the illustration and photogaphy support is also a major annual contribution to CCIW.

The Field Support was provided to approximately 75 studies by meeting with and identifying the needs of the scientists, suggesting and implementing methods and procedures necessary to make the various measurements required, maintaining close liaison with other divisions and agencies to coordinate the logistical requirements, and reporting upon the completion of the job. One of these support functions was the installation of a weather station on the Burlington Pier from which are obtained daily recordings of meteorological parameters for inclusion in our data file relative to many studies being conducted in the immediate area.

SSD staff were responsible for the successful completion of the Ontario region's Open Lake Surveillance Program. There were 12 surveillance cruises conducted in Lake Ontario, three in Lake Erie and one each in Lake Superior and Lake Huron. The majority of these were conducted aboard CSS Limnos and the remainder using the charter vessel MV Petrel V. The data gathered on these cruises are included in the annual report to the International Joint Commission (IJC).

Engineers and technicians also provided significant support to the Department's Canadian Oceanographic Data System (CODS) Program. In October a meteorological toroidal buoy was moored off Halifax as part of the overall evaluation and intercomparison program of the buoys being developed. Motion of the buoy was measured over a several day period, including a severe storm, and inter-compared with other types of buoys. The proposed buoy for the Great Lakes developed by the contractor, Hermes Electronics, was also field tested in Lake Ontario.

The digital plotting capability in the Data Centre was considerably enhanced this year by the replacement of the plotting equipment with the new Calcomp 1036 system. The new system provides a five-fold increase in the amount of plotting that can be accomplished in a day as well as a great improvement in the quality of the product.

During the year staff of the unit have been involved heavily with the planning and defining requirements for the acquisition of a new computer system for the Centre. Major areas of involvement included the preparation of the technical specifications for the new hardware and system software, and the design and testing of the benchmark job stream to be used to evaluate tenders for the new system.

The use of computer services continued to increase during the past year, the most dramatic being an increase of 24% in the central processor time for the main 3170 system, to 1903 hours. Other statistics for 1976/77 are given in Table 1.

In support of the Research Programs at the Centre, the Library has collected 17,100 books, received 590 journal titles, 441 series reports and during the year obtained 1732 items on interlibrary loan at the request of research staff. Eight hundred and fifty interlibrary loan requests were received for items from CCIW library's collection. Library services were extended to the Great Lakes Biolimnology Lab staff at Sault Ste Marie, and to the EMS Regional Director's staff in Burlington in addition to the groups previously served, i.e., all staff at the Centre and IWD Ontario Region personnel.

On-line searching of information from computerize data bases continues to supplement manual searching CAN/OLE was used approximately 2-½ hours a month and QI systems (WATDOC) are queried between 12 and 77 times month.

The library staff are coordinating their efforts wit other library groups, such as the Sheridan Park Library and th Information Science Committee, in sharing resources in a effort to decrease the number of journals needed on site, an this cooperation has proved very fruitful during the year Coöperation with the staff of environmental libraries aroun the Great Lakes Basin will be evaluated in the Spring.

Scientific Advice to Others

Staff from the Scientific Support Division hav provided considerable technical information to Canadian scien tists, engineers, and to Canadian Industry. The most notab case is the advice provided to Hermes Electronics, the prin contractor for the CODS Program. This program involves th development of buoy systems for the oceans as well as Canada inland waters. Staff from this Division are concerned with th development of the intermediate or medium capability buoy an provide primary consulting services to the contractor on desig fabrication, mooring, deployment and application of the systems.

STAFF SERVICES DIVISION

Staff Services included lead agency provision of asic administrative, financial, material, records, and property nanagement to all Environmental Management Service elenents located at the Centre. In addition, common services vere provided to other services of the Department of Fisheries nd Environment, i.e. Fisheries and Marine Service, Environnental Protection Service, Planning and Finance (Personnel) nd to the Department of Supply and Services Procurement)ffice.

Secretariat service is provided to the Executive ommittee, complemented by supporting committees such as acilities Committee, Safety Organization and the respective ubcommittees: security, fire prevention, energy conservation, nd others. Direct administrative support was further provided o the Director's Office, Senior Scientist, Office of Coordinaion, Information Services, and the World Health Organization.

With the introduction of EMS Program Planning, rogram/Project reporting quarterly required by regionalization nd the associated complexities, a whole new dimension of inancial data control is being developed.

Points of specific interest resulting from the epartment of Supply and Services audit and other department itiatives are as follows:

ccounting

New procedures for the control of expenditures, cluding proper implementation of the Delegation of Signing uthorities, were introduced; and the introduction of comshare inancial computer systems for greater response to management formation needs with emphasis placed on project reporting as planned.

The Financial Officer position was vacant from lovember through March, thus creating a difficult period for xisting staff.

The many restraints, control directives, and inquies resulting from the Auditor-General's activity reflected eavily on all financial matters.

ilding & Property Services Section

The Building & Property Services Section provides ilding, site, and built-in equipment support for all components CCIW. This support covers the operation and maintenance of e facilities, alterations, new construction, modifications and chnical advice on the use of these facilities which may be quired to satisfy the requirements of the research programs. is section is also responsible for the safety, fire emergency, d security programs for the Centre.

CCIW intensified its energy conservation activities ring the 1976/77 fiscal year which dramatically reduced ectrical consumption by 3,702,200 kilowatt hours and natural s consumption by 37,046,000 cubic feet over the previous cal year.

The project to upgrade the existing ship's terminals meet new power requirements, bilge and sanitary drains, c., and the installation of an additional ship's terminal was mpleted. All terminals are now equally equipped allowing ean and Aquatic Sciences more flexibility in berthing ships.

A fish culture laboratory, approximately 45' x 114' is created for the Great Lake Biolimnology Laboratory in the draulics Laboratory and entailed the moving of eight Lake lumn Simulators within this new laboratory and relocating Hydraulics meter calibration shop to a newly constructed p within the confines of the Hydraulics observation deck.

An agreement between the Hamilton Harbour Commissioners and CCIW was executed, granting the HHC permission to install and operate a radio transmitter unit complete with tower at CCIW.

All service, minor construction and purchase contracts related to the operation and maintenance of CCIW were carried out by this Section, utilizing the Facilities Planning Systems and Procedures Manuals.

Fire Protection, Safety & Security

New procedures for safety and security effectiveness were planned for implementation early in 1977/78. Regrettably the Safety Officer's position remained vacant January through March.

A potentially serious fire, 10 February 1977, located in the large warehouse, thought to be caused by chemical reaction in the receiving area, was quickly controlled, and the subsequent investigation by the Dominion Fire Commissioner's office resulted in new protective fire equipment and procedures.

Materiel Management

Steps were taken to establish a proper record of the Centre's assets and implement the departmental Equipment-in-Use System.

Vehicle control and reporting was updated to meet departmental standards.

The review of assets has clearly indicated that an agressive disposal program should be instituted.

Procedures for the provision of common services to all tenants have been reviewed and improved with particular reference to the control of chemicals and other lab supplies, personal issues of protective clothing and field equipment, stationery, etc.

During the past year we underwent a detailed and constructive DSS Audit Services Bureau Audit conducted by Mr. T. Thompson. Observations were made on how we could improve Materiel Management and the many services it provides have been implemented to the extent our resources allow.

The on-going results of the Audit in conjunction with Departmental requirements resulted in the new Equipment in Use System being implemented. A complete physical inventory of CCIW Branch is in progress.

During the year 1976/77 Materiel Management supplied full or partial service to the Regional Director's Office, Ocean and Aquatic Sciences, Environmental Protection Service, Inland Waters Directorate Ontario Region, Great Lakes Biolimnology, Small Craft Harbours, Lands Directorate, the Director's Office, and the five (5) Divisions of CCIW Branch.

To meet the needs of components serviced required the following actions:

(a) 8095 Procurement Documents were actioned.
(b) 3950 Internal Requisitions were filled from CCIW Stocks of Common Users Stores (stationery, laboratory and field supplies).
(c) An average of 300 Request for Information and/or Expediting forms were processed monthly.
(d) 20,839 pieces were received by the Warehouse.
(e) 5305 pieces were shipped by the Warehouse.

(f) Recording of activity on approximately 7000 Capital Asset record cards continued.

(g) Labour was supplied throughout the Centre - re furniture movement by requisition from stock as well as the many relocations of offices.

(h) User units were serviced, with custodial Warehousing, and associated work was performed, e.g., Fork-Lift operation.

(j) Central reporting of twenty-nine CCIW vehicles was coordinated. Bookings were scheduled in support of all CCIW Branch for use of the five Staff Services vehicles.

(k) Driving service was supplied to the Personnel and Financial Sections on a weekly basis and other "Emergency" driving requests were responded to.

REGIONAL REPORTS

CCIW BRANCH, PACIFIC & YUKON REGION

RESEARCH ACTIVITIES

In 1976-77, the CCIW Branch, Pacific and Yukon Region, commenced a three year, interdisciplinary, limnological study of Kootenay Lake, B. C. Completion of dams on the two major rivers entering this large, short-residence-time lake has substantially decreased the water flow during spring freshet and increased it during winter. The purpose of this study is to examine the effects of the hydrographic inversion on physical circulation patterns, thermal characteristics, chemistry, geochemistry, sedimentology and microbiology. Secondary interactions with nutrient pollutants in the watershed will also be examined. The data will be used to assess future options for watershed management, including a possible water diversion scheme under the terms of the Columbia River Treaty and potential changes in the method of lake operation by the regional hydroelectric authority.

An integrated, monthly lake survey was first established. Measured variables include temperature, turbidity, conductivity, major cations and anions, all particulate and dissolved carbon, nitrogen and phosphorus fractions, algal biomass, productivity and excretion, bacterial biomass and relative activity, chlorophyll, ATP, and zooplankton numbers. Continuous measurements of lake and river temperatures were also obtained using in situ sensors. In addition, sediment samples were collected for subsequent analyses of grain-size, mineralogy, and trace and major element concentrations.

A preliminary examination of the descriptive data shows that the incoming river waters rapidly transit the lake as relatively coherent overor interflowing water masses. These "riverine" flows appear to dominate the physical/chemical processes of the lake and may, directly or indirectly, affect microbial productivity. Both convective overturn and summer stratification are controlled in large part by this lateral movement of water, as is the spatial and temporal distribution of primary nutrients. Specific research attention has thus been focused in the following areas:

(1) Direct measurements of horizontal current structure using VAPS instrumentation (with Dr. P. Hamblin);

(2) Determination of net nutrient fluxes in and out of the lake (with Pacific and Yukon WQB) and between water masses within the lake;

(3) Detailed correlations of physical and chemical variables by a modification of oceanographic techniques for water mass analysis;

(4) Direct correlations of temperature and algal distribution patterns using an in vivo fluorescence profiler; and;

(5) Examination of short-term changes in carbon, nitrogen, and phosphorus dynamics in relation to riverine- and wind-induced physical and chemical changes, expecially during the summer period of apparent nutrient insufficiency (with Dr. D. Lean).

Lastly, a cooperative study is underway with Dr. D. Lasenby, Trent University, to describe the general ecology of *Mysis relicta*, the carnivorous freshwater shrimp introduced into the lake in the 1950's, in relation to hydrographic alterations.

CCIW BRANCH, WESTERN AND NORTHERN REGION

The Canada Centre for Inland Waters Branch, Western and Northern Region (CCIW-WNR) is located in the Freshwater Institute on the University of Manitoba Campus in Winnipeg. The objective of CCIW-WNR is to provide scientific knowledge of assistance in managing the freshwater resources of western and northern Canada. The main function is applied research into the responses of regional freshwater systems to various stresses related to human activities, or their removal, at specific sites in the Prairie Provinces and the Northwest Territories. A subsidiary function is the investigation of key limnological processes controlling these responses. The main stresses under investigation are, in order of priority:

(1) excess nutrient loading from urban and agricultural sources, particularly sewage from major population centres;

(2) toxic substance loadings, from industrial, agricultural, and urban sources, with emphasis on heavy metals from mineral processing plants;

(3) waste heat from industrial sources, particularly coal-fired, thermal generating stations.

For convenience, the freshwater system of western and northern Canada can be separated into five groups:

(1) Prairie Lakes;
(2) Reservoirs;
(3) Taiga Lakes:
(4) Great Lakes; and
(5) Rivers.

Applied limnological research in relation to one or combinations of the above stresses is underway at sites representing each of these five groups.

The effects of reducing excessive nutrient loadings to shallow Prairie Lakes is presently given priority. The main study site is the chain of six lakes downstream from Regina in the Qu'Appelle Valley of Saskatchewan. These mainstem lakes, like many in the Prairie region, are shallow and although flushed during a spring when there has been sufficient winter snowfall, still have relatively long water residence times. Given this situation, natural nutrient loadings are considered sufficient to generate noxious algae blooms. The natural situation is made worse by massive injections of nutrients from Prairie population centres, agricultural activities, and recreational developments. The Fishing Lake chain (Lakes Pasqua, Echo, Mission, and Katepwa), Crooked Lake, and Round Lake occur on the mainstem river draining the interprovincial Qu'Appelle basin. Under a Federal-Provincial agreement, some ten million dollars has been allocated for facilities and procedures to reduce nutrient loading to these lakes. Based on a limited data base and limited investigation of processes which occur in this particular limnological milieu, predictions were made as to the effects of nutrient loading reduction in terms of water quality improvement, particularly the hoped for decrease in intensity and/or frequency of algae blooms. The purpose of the ongoing research is to refine these earlier predictions.

Ongoing research activities by CCIW in the Qu'Appelle system include the following:

(1) Nutrient Loading Models. Compilation and verification of existing data on nutrient loading from rivers. Interpretation of these data, in conjunction

with relevant information on the hydrologic cycle, according to state-of-the-art theories of nutrient-water residence times and nutrient loading equations. So as to refine loading models, measurements of nutrient loadings to the lakes from wet and dry precipitation and groundwater flows, both natural and affected by recreational facilities, are being made.

(2) Nutrient Loading-Productivity Models. Interpretation of historic nutrient loading-productivity relationships for those periods when productivity measurements are available. Ongoing studies include analyses of the water column in all six lakes for a variety of physical and chemical parameters and chlorophyll-a measurements. Wind-generated depth-turbidity relationships are being investigated by transmissometer fixed in Echo Lake and a shore-based meteorological station. Surface turbidity variations are being assessed by boat-mounted transmissometer and, under contract, by interpretation of satellite imagery. Landsat imagery will also be used to assess variations in lake biomass during previous flood and drought years, by correlation of today's imagery with today's productivity. For logistical reasons and because of problems related to recreational development in the Qu'Appelle valley, a more ambitious study of mixing processes in shallow Prairie Lakes is underway in Lake Manitoba. A sophisticated hydrometerological tower is installed in the lake during summer months. The objective is to investigate the interaction of sediment resuspension, productivity, and depth of the euphotic zone, with wind-generated bottom stress.

(3) Internal Regeneration of Nutrients. The nutrient loading and productivity studies and models described above will assist in defining the extent of regeneration of phosphorus from sediments. Considered a major component in the nutrient budget of Prairie Lakes, this process is also being investigated by chemical analyses, using selective extraction techniques, and by microprobe analysis of bottom sediments. Determinations are also being made of bio-availability of sediment- and humus-bound phosphorus by direct algae growth on sediment substrates.

(4) Historical Nutrient Loading and Eutrophic State. Sediment cores, collected through ice with the CCIW lightweight corer are being analysed by selective extraction techniques to determine historic inputs of nutrient forms to the lakes. Sedimentation rates are being determined on selected cores by radiometric techniques. Historic changes in trophic state are being estimated following computer analyses of ostracod distribution and species composition.

(5) Pollution Indexing. A benthic survey of the six mainstem lakes in the Qu'Apelle valley is nearing completion. It is expected to extent sampling to the river itself. Because of their response to the total environment, benthic studies provide a better means of indexing the impact of contaminants, in this case excessive nutrient additions. The unbalanced nature of the benthic communities in some of the mainstem lakes, mainfests the stress being imposed by the excessive nutrient and other inputs to the lakes. A bacteriological survey of the bottom sediments is tentatively planned for some future date.

(6) Nitrogen Fixation. Because of the dominance of nitrogen-fixing blue-green algae in many Prairie lakes, a study of the N-fixation process is being carried out at lakes near Erickson, Manitoba, as part of the overall Prairie lake limnology programme.

The investigations described above absorb most of the budget for regional limnological research. However, many other limnological sites in the region are the focus of diverse environmental problems. In the future, some of these may be given priority because of Federal-Provincial agreements or similar arrangements. These site-specific problems are tackled on a very limited basis in anticipation of future priority changes or environmental concerns. The investigations fall into three general categories.

(1) Toxic Metal Pathways. Research into the pathways of regeneration and recycling of toxic metals in taiga lakes contaminated by waterborne and airborne loadings from mineral extraction plants is conducted at Flin Flon, Manitoba. A related investigation of the limnological pathways of copper originating from algicides involves analyses of sediments, water, and biota from the lakes near Erickson, Manitoba, and the mainstem Qu'Appelle Lakes, Saskatchewan.

(2) Toxic Metal Dynamics and Loadings. Research into heavy metal dynamics of the great lakes of the region began with analyses of sediment cores from Lake Winnipeg, has recently extended to Lake Athabasca, and will continue with limited sampling of Lake Manitoba and Great Slave Lake. The Lake Athabasca bottom sediments were collected as part of an Alberta Oil Sands Environmental Research Programme (AOSERP), a funded study of the dynamics of heavy metals in the Athabasca river system. As time, budget priorities, and technical support permit, cored sediments are analysed, and sedimentation rates determined, to calculate historical changes in loadings of various toxic substances to these western great lakes. Related extensions of these investigations are anticpated for: (1) Lake Winnipeg as part of a proposed Federal-Provincial water quality study, and (2) mercury in the Winnipeg River drainage basin as part of a similar Federal-Provincial investigation of rivers and lakes of northwestern Ontario. Knowledge is being built up of the dynamics of heavy metal transport to Lake Winnipeg via analyses of bottom sediments and suspended sediments from the Red River and from other lakes and rivers in the Lake Winnipeg drainage basin. A study of the mass transfer of water between the north and south basins of Lake Winnipeg has been completed. This involved the use of current meter chains, to continuously monitor water movement in the Lake Winnipeg Narrows.

(3) Reservoirs and Impoundments. Boundary Reservoir in southeastern Saskatchewan is the major study site. It is the location of a large, lignite coal-fired generating station. Research is aimed at determining the effect of both waste heat and the generating station on water quality. Results of physical and chemical studies on this riverine reservoir are applicable to other international boundary reservoirs. Chemical studies have dealt with sediment analyses aimed at elucidating the major cation and toxic metal balances in the reservoir. Physical studies have dealt with winter, ice-free surface evaporation, so as to more accurately estimate water loss from these Prairie reservoirs. A different type of reservoir study aimed at the estimation of productivity changes in impoundments has recently been completed. This study site was Southern Indian Lake which is a main component of the Churchill-Nelson diversion.

Publications or manuscripts dealing in more deta[il] with several of the above topics are available from CCIW-WNF Freshwater Institute, Winnipeg. Data on most of the above a[re] presently being accumulated and staff members in Winnipeg c[an] be consulted on specific topics.

PUBLICATIONS

WORLD HEALTH ORGANIZATION COLLABORATING CENTRE ON SURFACE AND GROUND WATER QUALITY

Water Quality Bulletin, 1976-77:
Bulletin de la qualité des eaux, 1976-77:

Vol. 1, No. 1,	Water Management in Canada, January Gestion des eaux au Canada, Mars
Vol. 1, No. 2,	Water Management in Latin America, April Gestion des eaux en Amérique Latine, Avril
Vol. 1, No. 3	Water Management in the Western Pacific, July Gestion des eaux dans le Pacifique de l'ouest, Juillet
Vol. 1, No. 4	Water Management in Eastern Europe, October Gestion des eaux dans l'Europe de l'est, Octobre
Vol. 2, No. 1	Water Management in the USA, January Gestion de la qualité des eaux aux E-UA, Janvier

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- Member, International Association Great Lakes Research
- Member, Editorial Board of the "Memorie dell' Istituto Italiano di Idrobiologia", Verbania-Pallanza, Italy

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- Member, American Chemical Society
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- Member, Editorial Board, Hydrological Sciences Bulletin
- Member, Upper Lakes Reference Group, Editorial Committee

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	Member, Ecological Effects of Non-phosphate Detergent Builders (IJC Task Force)
	Member, Mercury in the Environment (DFE Task Force)
N. W. Burns	Chairman of session on Chemical Limnology at the Great Lakes Conference, May 1976.
B. K. Burnison	Co-Chairman for Heterotrophic Activities of the "Native Aquatic Bacteria" Task Group for ASTM.
Y. K. Chau	Elected member of Canadian Advisory Committee of the International Standards Organization, Technical Committee 147 on Water Quality.
	Member of ASTM (Amer. Soc. Testing Materials) Task Group on Chemical Testing of Sediments, D-19, 07,03, 03,
C. I. Dell	Adjunct Professor, Department of Earth Sciences, University of Waterloo.
	Member, Publications Committee, International Association for Great Lakes Research.
	Chairman, Search Committee for new editor, Journal of Great Lakes Research.
	Member, Editorial Review Board, Journal of Great Lakes Research.
	Member of Upper Lakes Multidisciplinary Discussion Group.
L. D. Delorme	Organizer, SIL-Working Group Seminar.
W. A. Glooschenko	Invited member of PLUARG panel on pesticides.
	Member Hudson Bay Lowlands Study Working Group
K.L.E. Kaiser	IWD-CCIW representative to the Interdepartmental Task Force on Mirex.
J. Lawrence	Program Committee of Canadian Water Resources Associates.
	Vice Chairman of Ontario/Quebec Section of Electrochemical Society.
	Chairman of Lash Miller Electrochemistry Award Committee.
	Member of CCIW Toxic Substances Group.
D.R.S. Lean	Member of Science Advisory Committee - CCIW
	Member of CCIW Modelling Group
G. Leppard	Promotion of collaboration between selected external laboratories of excellence and PRD laboratories. The external laboratories include: the Cell E physics Group at the NRC un Dr. J. R. Colvin, the Cell Physiol Group of Dr. D. L. Brown at the Univ sity of Ottawa, the Ottawa River Proj Microbiology Group under Dr. D. Kushner, the Bacteriology Group of R.G.E. Murray at the University of W tern Ontario, and the Microbial Struct Group of Dr. J. W. Casterton at University of Calgary.
J. O. Nriagu	Member, Environmental Geochemis Committee of the Geochemical Societ
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B. G. Oliver	Program Chairman for the 23rd Canadi Spectroscopy Symposium, Lond Ontario.
	National Membership Chairman of t Spectroscopy Society of Canada.
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B. F. Scott	Member of International Standar Organization, Technical Committee 14 Working Group 15 (Petroleum and Petr leum Products).
	IWD-EMS representative on Adviso Group on Research and Developme (EEB-EPS).
	Member of Working Group on Fate a Effect of Oil-a subgroup of AGRAD.
	Member of Departmental Environment Emergency Team (EPS) for CCIW.
P. G. Sly	Canadian Research and Developmen Scientific Editor.
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	Great Lakes Working Group on Dredgin
	Climatological studies (with O&AS a AES) working group.
	Marine Technology Advisory Committe Seneca College.
	Hamilton-Scourge Steering Committ (with ROM, OMCR, DINA).
	Member UNESCO Working Group Sediment Sampling Procedures etc.
W.M.J. Strachan	Member, Scientific Basis for Water Qu lity Criteria Committee/Task Force the IJC-Research Advisory Board.
	Member, Environmental Contaminan Act Advisory Committee.
	Member, CCIW Toxic Substances Grou
	Member, CCIW Branch Research Prog ram Committee.

. L. Thomas

Member, Pollution from Land Use Activities Reference Group, IJC.

Member PLUARG, Canadian Task D Technical Committee

Member PLUARG, Editorial Committee.

Member Steering Committee for a Workshop, on the transport of sediment associated nutrients and contaminants in fluvial systems.

.D.H. Williams

Advisor to the Sedimentology Group of Dr. J. P. Vernet, University of Geneva, on analysis of lake sediments.

Member ASTM Task Group on Chemical Testing of Sediments.

. J. Dutka

American Water Works Association (AWWA) - Microbiology Problems Committee

International Joint Commission (IJC) - Chlorine Objectives Task Force

Organized Microbiology Seminar with three European speakers on Water Quality Indicators and Sanitary Microbiology

Organized and Co-Chaired the ASTM International Symposium on Bacterial Indicators of Potential Health Hazards Associated with Water

American Public Health Association (APHA) - APHA Standard Methods Committee to review and rewrite the 14th Edition of APHA Standard Methods

Editorial Review Board for Journal of Great Lakes Research

Review of EPA Recreational Water Quality Criteria Program

DFE and NH&W Chlorination Committee

Peer Review of Ministry of Housing Lakeshore Capacity Study

Canadian Chairman of International Standards Organization (ISO) Subcommittees
SC4 Microbiology
SC5 Biological Methods
SC6 Sampling Methods

Chairman, ASTM Microbiology Subcommittee D19:24

Referee for Symposium "Water Pollution Research in Canada"

IJC Standing Committee on Health Aspects

Consultant and Participant to EPS Grey Water Study

. S. Rao

CCIW Surveillance Task Group

Participated in Workshop "Environmental Mapping of the Great Lakes", organized by the IJC

Participated on "Program and Abstract" Committee of 19th Conference on Great Lakes Research

Acted as Chairman of Session 4D "Microbiology - Oxygen Relationships" at the 19th Conference on Great Lakes Research

B. K. Afghan

Chairman, ASTM's working group on standardization of methods for nutrients in sediments

Member of ISO's working group on estimation of biomass in aquatic environment

Chairman of Subcommittee SC2 of the Canadian Advisory Committee of Standard Council of Canada

R. W. Durham

Chairman, IJC Water Quality Board's Radioactivity Subcommittee

Dr. T. M. Dick

Chairman, Membership Committee, Canadian Society for Civil Engineering

Member, Technical Operations Committee, Engineering Institute of Canada

Canadian Member, Committee on Maritime Hydraulics, International Association for Hydraulic Research

Member, Executive Committee, Hydrotechnical Division, Canadian Society for Civil Engineering

Chairman, Keefer Medal Award Committee, Canadian Society for Civil Engineering

Dr. M. A. Donelan

Chairman, "Van Wagner's Beach Tower Management Committee"

On Ph. D. Advisory Committee of Mr. M. A. Al-Zanaidi (Department of Applied Mathematics, University of Waterloo)

Dr. Y. L. Lau

Member, Ph. D. Supervisory Committee at McMaster University, Department of Civil Engineering

J. Marsalek

Member, Urban Drainage Subcommittee, Canada-Ontario Agreement

Member, Urban Drainage Manual/Policy Committee, Canada-Ontario Agreement

Dr. N. A. Rukavina

1976 - Associate Editor - GEOSCIENCE CANADA, Geological Association of Canada

1976-77 - Associate Editor - Journal of Great Lakes Research, International Association for Great Lakes Research

1977 - Member, Ad Hoc Committee on CCIW/NHRI Interaction (T. M. Dick, Chairman)

Member, Unnamed committee of shoreline geomorphologists advising EPS on oilspill countermeasures

Dr. G. Tsang — Working group on Ice Covered Rivers: Associate Committee on Geotechnical Research, NRC

Prairie Region Oil Spill Contaminant and Recovery Advisory Committee

A. J. Zeman — 1977 - Member, Ad Hoc Committee o[n] CCIW/NHRI Interaction (T. M. Dic[k] Chairman)

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- Mrs. E. Kerr
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Researchers:

Dr. P. G. Manning - phosphorus & iron in sediments
Dr. B. Brownlee - nitrogen metabolism, forms of dissolved organic nitrogen
Dr. B. K. Burnison - microbial ecology
Mr. M. N. Charlton - biomass and productivity response of nutrients
Dr. D. B. Schindler - microbial ecology
Dr. N. M. Burns - nutrient cycles, organic flocs
Dr. G. G. Leppard - algal ultrastructures; filaments and nutrient uptakes

Technicians: Mr. D. Nuttley, Miss S. E. Jackman, Mr. K. Edmondson (term), Mr. T. Murphy, Mr. F. Rosa

Toxic Substances Section

Head - Dr. W.M.J. Strachan - persistent organics, cycles, and distribution

Researchers:

Dr. Y. K. Chau - trace metals, methylation, complexation
Mr. M. E. Fox - persistent and semi-persistent organics
Mr. H. Saitoh - Mercury, methylation, etc.
Mr. K. Lum Shue Chan - education leave
Dr. B. F. Scott - oil spills effects on ecosystems, climati[c] regimes
Dr. K.L.E. Kaiser - persistent and volatile organics
Dr. E. Nagy - water-soluble components of oil, persistence, significance
Dr. D. Liu - persistent toxic organics, degradability, metabolites
Dr. R. J. Maguire - selected toxic organics, distribution, transformation

Technicians: Mr. G. A. Bengert, Mr. H. Huneault, Mr. J. Hart, Mrs. K. Kwasniewska, Mrs. E. Hale

Water Chemistry Section

Head - Dr. J. Lawrence - treatment of potable water

Researchers:

Dr. B. G. Oliver - effects of chlorination on receiving waters, photochemical processes
Dr. R. E. Platford - Partition coefficients of solutes between water and petroleum products

Technicians: Mr. E. G. Cosgrove, Mr. H. H. Dobson

Paleoenvironment Research Section

Head - Dr. L. D. Delorme - quantitative techniques, autecology of shelled invertebrates

Researchers:

Dr. L. L. Kalas - autecology of land snails

Technicians: Mr. M. Denford

Support Staff: Mr. V. Hanson

Geology Section

Head - Dr. A.L.W. Kemp - geochemical budgets, large lake systems

Researchers:

Mr. H.K.T. Wong - geochemistry of sediments
Mrs. A. Mudroch - wetland areas - release/retention of nutrients and toxics
Dr. W. A. Glooschenko - ecology and geochemistry of Hudson Bay, James Bay lowlands
Dr. C. I. Dell - Mineralogy of lake sediments
Dr. J. O. Nriagu - geochemistry of lake metals, sulfur isotope studies
Dr. J.D.H. Williams - phosphorus geochemistry (developmental leave, October 1976 - October 1977)
Mr. R. K. McMillan - suspended sediments in tributaries

Technicians: Mrs. N. Harper, Mr. J. Capobianco, Mr. W. G. Boc[k], Mr. R. D. Coker, Mrs. T. Mayer, Mr. T. W. Morto[n], Mr. R. G. Sandilands

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nalytical Methods Research

lead - Dr. B. K. Afghan - High pressure liquid chromatography, polarography, molecular fluorescence spectrometry
Secretary - vacant

esearchers:

Ir. T. Bistricki - electron microscopist
Ir. P. D. Goulden - automation & atomic spectroscopy
Ir. I. Sekerka - electroanalytical
Ir. F. I. Onuska - Gas chromatography & GC/MS
Ir. R. S. Tobin - Analytical biochemistry
Ir. R. W. Durham - radiochemistry

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esearchers:

r. S. S. Rao - microbiology

echnicians: Mr. A. A. Jurkovic, Mr. A. K. Kwan, Ms. K. Switzer-Howse, Ms. D. E. Doerffer, Mr. S. R. Kuchma, Mr. R. McInnis

emote Sensing Section

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Dr. E. C. Chen - oil and ice
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Dr. B. G. Krishnappan - river models
Mr. J. Marsalek - urban hydrology
Dr. M. G. Skafel - coastal engineering
Dr. G. Tsang - ice studies

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Mr. A. J. Zeman - geotechnical studies

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Dr. T. A. Jackson	- biogeochemical pathways - nutrients and toxic metals
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Mr. M. R. Thompson	- erosion studies, HRD
Mr. E. H. Walker	- persistent contaminants, GLBL
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Mr. T. J. Carew	- WAVES'76 and REX

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Limnos: Mr. B. H. Moore, Mr. S. B. Smith

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Mr. F. J. deVree	- diver
Mr. F. H. Don	- diver

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Mr. L. J. Lomas	- foreman
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Mr. B. Malseed	- computer console operator
Ms. U. Hamilton	- computer console operators
Ms. J. Foley	- keypunch & peripheral operator

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Head - Mr. C. F. Hicks

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